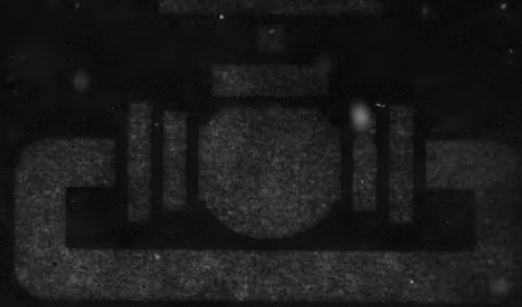


SOUR GAS STUDY

Of The Calgary Region



August 1985

Calgary Regional Planning Commission
C.E.P. Consultants Ltd.
J.R. Century Petroleum Consultants Ltd.

SOUR GAS STUDY
of the Calgary Region

BY:

CEP Consultants Ltd.,
J.R. Century Petroleum Consultants Ltd.,
and Calgary Regional Planning Commission.

June 1985

This report represents a compilation of information from both the Interim and Final Sour Gas reports. It is intended that this report provide both technical and policy information for consideration by agencies and groups directly involved with the sour gas industry and the land use planning process.

It should be noted that every effort has been made to ensure the accuracy of the mapping of information presented in this report. However, minor discrepancies and omissions may have occurred due to the diverse sources and scales of information.

We wish to acknowledge the assistance of staff members of the ERCB and the operators of Sour Gas facilities within the Calgary Region in the preparation of this report.

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STUDY PROCESS

This study was initiated and funded by the Calgary Regional Planning Commission and was undertaken by CEP Consultants Ltd. in conjunction with J.R. Century Petroleum Consultants Ltd., in October 1983. The Commission was responding to the Energy Resources Conservation Board's request that it become more involved in the land use implications of sour gas development in the Region.

The three (3) objectives of the study were:

- i) to provide an inventory of sour gas reserves and facilities within the Calgary Region;
- ii) to develop land use management strategies for areas affected by reserves and facilities; and
- iii) to formulate appropriate policies for inclusion in the Regional Plan and at the discretion of local planning authorities, in local planning documents as defined in the Study's Terms of Reference.

In February, 1984, the Interim Report addressed the first of these objectives. The report contained the following components: an inventory of proven and potential reserves and facilities; a description of the regulation and control agencies of the sour gas industry and an overview of the land use planning policies of the Region; and a review of the potential conflicts or relationships between the use of the land and the continued development of the sour gas industry.

The second phase of the study, or Final Report was produced in June, 1984. This report addressed the second objective, in that areas were identified, within the Calgary Region, where the sour gas industry may potentially conflict with or have an impact upon the existing and potential urban and rural land use patterns. The potential conflict areas were described in detail and management strategies were examined to reduce potential land use conflicts between surface and subsurface development.

The information from these two reports is included in this document. As well, an analysis of this preliminary data and the resulting recommendations, as endorsed by the Calgary Regional Planning Commission is included. With respect to the third objective identified above, the findings of the study indicate that the approval process and regulations established and implemented by the Energy Resources Conservation Board are adequate. It was determined that they would not be significantly improved by the addition of regional policy. However, the recommendations presented and discussed herein provide a method of monitoring sour gas development within the Region and focus attention on the important issue of minimizing potential land use conflicts.

INTRODUCTION

What is Sour Gas?

For the purpose of this report natural gas comes in two varieties, sweet and sour. By definition, sour gas contains greater than 1% hydrogen sulphide (H_2S) requiring special equipment and regulations.¹ Sweet gas contains 1% or less of H_2S . The hydrogen sulphide concentration in sour gas varies, when concentrated it is dangerous and odourless. In lesser concentrations, it is potentially hazardous and has an easily recognizable "rotten egg" smell.

Regardless of the hydrogen sulphide characteristic, the decision to produce natural gas is enhanced by the liquid content of the gas containing marketable by-products such as propane, butane and ethane. In addition to the natural gas market, these by-products provide additional profits. Therefore, wherever natural gas occurs with a high liquid content, that gas is an attractive resource.

Sour Gas Reserve Development in the Region

In the Calgary Region, large natural gas reserves underlie most of the land. Since more than half the proven gas reserves in the Calgary Region and immediate vicinity are sour, it is important that these occurrences are carefully investigated and documented for planning purposes. There are currently 9 sour gas processing plants within the Region's boundary and a total of 40 throughout Alberta. It is evident that the sour gas industry is an extensive and significant economic force, both regionally and provincially.

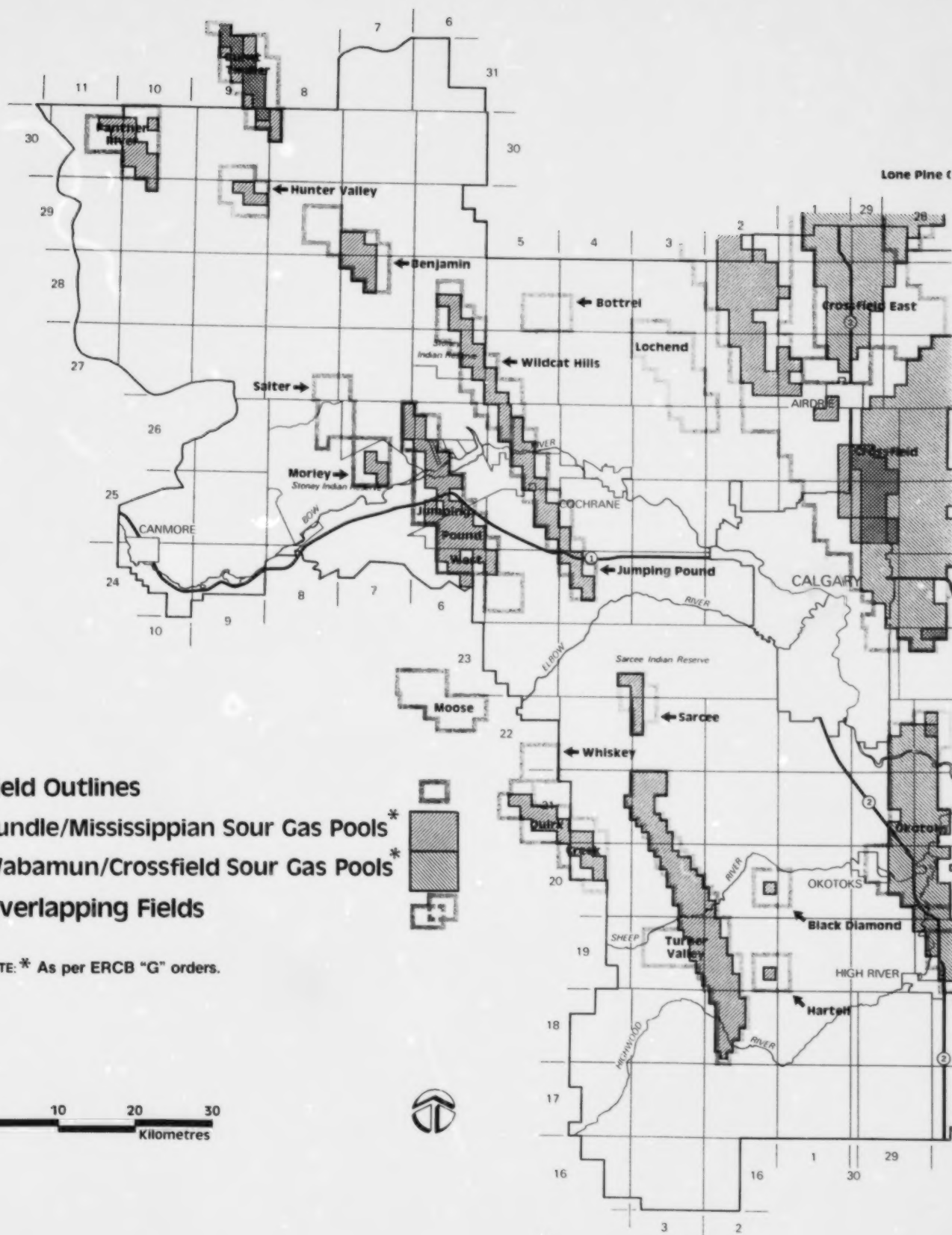
The hydrogen sulphide content of sour gas and the health hazard it may present in higher concentrations, has spawned a further industrial process - sulphur recovery. Sulphur recovery occurs when the natural sour gas is processed at the plant. Sulphur recovery began in the Province in the 1950's in the Jumping Pound plant.

Over time, the sulphur recovery level increased to the present provincial average of 97.5% standard, due to the increased efficiency of sulphur recovery plant processes and the higher licensing standards of sulphur recovery guidelines set by the Energy Resources Conservation Board.

The future of natural gas production in Alberta is influenced by three major factors, in addition to the marketing factor:

- i) the continued exploration and development of reserves;
- ii) the ability to continue to produce gas from known reserves; and

¹ Source: ERCB Appendix to ID 81-3. Sour Gas is natural gas having an H_2S content of 10 moles per kilomole or greater or such lesser or greater H_2S that the ERCB may stipulate in a particular case.



Field Outlines

Rundle/Mississippian Sour Gas Pools *

Wabamun/Crossfield Sour Gas Pools *

Overlapping Fields

NOTE: * As per ERCB "G" orders.

Figure 1

Regional Gas Reserves

- iii) the regulations applied by the Energy Resources Conservation Board and the Provincial Government to the extraction of the resource in Alberta; and the National Energy Board and the Federal Government on export sales for the product.

The amount of sour natural gas that is currently produced, and will be produced in the future, is similarly affected by these factors.

The future of the sour gas industry and the ancillary sulphur production levels is also affected by the expected hydrogen sulphide concentration of future sour gas reserves. The Foothills area is characterised by higher hydrogen sulphide content gas, particularly in the Eastern Slopes, where concentrations as high as 75-95% have been identified. The eastern half of the Region contains sweet gas reserves. This is clearly illustrated in Figure 1 which shows both sweet and sour proven gas reserves in the Calgary Region.

Based upon known and potential reserves, and taking into consideration the various factors which will influence future production, it is calculated that the Calgary Region will provide approximately 10-15%¹ of the total gas and 30% of the sulphur production in Alberta. This production is expected to peak in the 1990's and decline thereafter according to a recent study by G.J. DeSorcy and H.G. Halladay of the Energy Resources Conservation Board. However, the Calgary Region does represent a significant portion of the total Provincial sour gas resource. This factor is significant when assessing land use impact and management policies for the future.

¹ Source: Derived from Table 3, see column totals.

1.0 INVENTORY

In compiling the following inventory of sour gas facilities, fields and reserves, meetings have been held with the Energy Resources Conservation Board (ERCB) and operators of processing plants and gathering systems or units. Information has also been supplied by Alberta Energy and Natural Resources, Edmonton.

The Calgary Region encompasses the Municipal Districts of Rocky View and Foothills; the County of Wheatland; Improvement District No. 8; and twenty-two urban municipalities including the City of Calgary. The Region comprises approximately 12,950 sq. km. (5,000 sq. miles) and a population of 692,000 people in 1983. However, since an individual field and pool may extend beyond the Regional Planning Commission boundaries, inventory information contained in this study may also be for those lands in the immediate vicinity of the Region.

1.1 Gas Fields and Pools

Figure 1 illustrates both the sweet and sour gas field in the Region. Those fields containing sour gas pools are described as follows:

TABLE 1
REGIONAL GAS FIELDS

<u>Formation Name</u>	<u>Geologic Period</u>
Rundle Formation	Mississippian
Elkton Member	Mississippian
Wabamun Formation	Upper Devonian
Crossfield Member	Upper Devonian
Nisku Formation (or D-2)	Upper Devonian
Leduc Formation (or D-3)	Upper Devonian

The formation name refers to the subsurface geological units in which the Region's sour gas occurs. Figure 1 shows that sour gas pools are present in the central and western parts of the Region, while the eastern half is underlain by sweet gas fields. The depth of these producing formations range from 2300-2650 m (7500 - 8700 ft.) in the vicinity of the City of Calgary to approximately 1920 - 4540 m (6300 - 14,900 ft.) in the foothills areas.

Source material for field outlines are derived from oil and gas maps prepared by the Alberta Department of Energy and Natural Resources,

based on data provided by the ERCB. In addition, pool outlines were determined from ERCB issued "G" orders along with producing formation or pool name.¹

Table 2 is a reserve inventory by geologic formation in the Calgary Region and immediate vicinity and Table 3 is an inventory summary of the sour gas reserves within the field and pools. As indicated on Table 3, four main headings describe each field and pool:

- i) Marketable Gas
- ii) Net Cumulative Production;
- iii) Remaining Established Reserves; and,
- iv) Average Percent Hydrogen Sulphide.

The purpose of this table is to illustrate quantitative aspects of the field reserves and the relationship between various pools or reservoirs. In addition, it is seen that sour gas produced within the Calgary Region to date accounts for 15% of all the natural gas (sweet and sour) in the Province of Alberta. Of the established proven natural gas remaining to be produced in Alberta, sour gas reserves in the Calgary Region account for approximately 9%.

Table 2
**RESERVE INVENTORY BY GEOLOGIC FORMATION
IN CALGARY REGION AND IMMEDIATE VICINITY¹ - 10⁶m³**

Pools	Initial Established Reserves	Net Cumulative Production	Remaining Established Reserves
Rundle	231,554	109,441	122,113
Wabamun	47,771	25,776	21,995
Crossfield	6,160	3,040	3,120
Elkton	4,162	2,861	1,301
Nisku & Leduc	3,418	542	2,876
Mississippian (Other)	17,480	12,820	4,660
D3-A	900	709	191
	311,445	155,189	157,156

¹Source: Alberta's Reserves & Crude Oil, Gas, Natural Gas, Liquids and Sulphur, ERCB Publication 83-18

¹ The omission of the Salter field-Mississippian pool and wells from the map figures is explained by the fact that a "G" order has not been issued by the ERCB.

Table 3
**Reserve Inventory of Sour Gas Pools
 in the Calgary Region and Vicinity¹**
 (at December 31, 1982)

		Marketable Gas - 10 ⁶ m ³			
Field & Pool		Marketable Gas Reserves	Net Cumulative Production	Remaining Established Reserves	Average % H2S
Benjamin	- Rundle	5,342		5,342	4.4
Black Diamond	- Rundle	38	33	5	2.4
Burnt Timber	- Rundle	14,410	6,054	8,356	6.5 - 13.2
	- Wabamun	2,000	291	1,709	29.7
Crossfield	- Rundle	51,855 ²	38,884 ²	12,971	0.1
	- Wabamun	14,600	9,262	5,338	10.5
Crossfield East	- Wabamun	12,000	6,956	5,044	34.9
	- Elkton	3,400 ²	2,861 ²	539	0.0
Drumheller	- Nisku	119	8	111	2.0
Garrington	- Elkton	762		762	0.0
	- Leduc	509	92	417	1.1
Gladys	- Rundle	314	4	310	5 - 10
	- Wabamun	600		600	no data
Harmattan-Elkton	- D3-A	900	709	191	52.0
	- Rundle	26,720 ²	5,536 ²	21,184	0.6
Hartell	- Rundle	92	74	18	3.3
Hunter Valley	- Rundle	1,685	555	1,130	13.8
Irricana	- Wabamun	1,640	345	1,295	6.9
Jumping Pound	- Mississippian	17,480	12,820	4,660	3.5
Jumping Pound West	- Rundle	48,373	14,773	33,600	3.8 - 8.5
Limestone	- Rundle	8,928	587	8,341	1.6 - 8.4
	- Wabamun	1,490	229	1,261	16.6
	- Nisku & Leduc	2,320	431	1,889(N) (Leduc)	15.7 - 17.7 13.1
Lone Pine Creek	- Rundle	42		42	0.5
	- Wabamun	8,366	4,825	3,541	12.0
	- Nisku & Leduc	158		158(N)	13.3
Mazeppa	- Wabamun	29		29	22.3
Morley	- Rundle	800	51	749	5.3
Moose	- Rundle	3,549		3,549	8.3 - 11.5
	- Wabamun	687		687	25.6
Okotoks	- Rundle	233	1	232	1.3
	- Crossfield	6,099	3,040	3,059	32.8 - 34.9
Olds	- Wabamun	6,174 ²	3,868 ²	2,306	8.3 - 29.0
	- Crossfield	61		61	0.5
Panther River	- Rundle	3,462	11	3,451	2.7 - 8.0
	- Wabamun			1	68.2 - 74.8
	- Nisku			1	70.4
Quirk Creek	- Rundle	10,252	4,984	5,268	8.0 - 17.9
	- Wabamun	185		185	45.9
	- Leduc	125		125	59.9
Salter	- Rundle	650		650	15.8 - 17.0
Sarcee	- Rundle	4,441	3,067	1,374	3.8 - 4.3
Savanna Creek	- Rundle	3,940	2,083	1,857	14.4
Turner Valley	- Rundle	37,000	36,000	1,531	0.8 - 2.0
West Drumheller	- Nisku & Leduc	187	11	176	1.7 - 2.5
Whiskey	- Rundle	3,139		3,139	8.3
Wildcat Hills	- Rundle	21,700	13,405	8,295	3.9
Wild Horse Creek	- Rundle	1,270	551	719	7.7
TOTALS		311,445 (10.7% of Alta) ³	155,189 (15% of Alta) ³	157,156 (8.8% of Alta) ³	

¹Source: ALBERTA'S RESERVES & CRUDE OIL, GAS, NATURAL GAS, AND SULPHUR, ERCB Publications, 83-18.

²Includes solution gas production

³Expressed as a percentage of all natural gas in Alberta

1.2 Sour Gas Facilities

These facilities consist of:

- i) the sour gas wells, both producing and capped or shut-in;
- ii) the pipeline gathering systems used for transporting the gas from the wells to the plants;
- iii) the sour gas processing plants themselves.

1.2.1 Information Sources for Data on Sour Gas Facilities

Well and plant locations were obtained from current Alberta Energy and Natural Resources oil and gas maps.

Other data sources for Figure 2 and the accompanying Appendix 3 detail maps include the ERCB, and the operators of the facilities.

Table 4
Gas Processing Plants in Calgary Region
and Vicinity¹ (September 1983)

Location	Fields Served	Plant Operator	(Production) Sulphur Tonne/d	(Licensed) Sulphur Emission Tonne/d	(Minimum Required) Rec Eff %
10-13-30-7W5	Burnt Timber, Hunter Valley, Wildhorse Creek, Panther River	Shell	489	12.25	96.0
SW¼ 27-3-30-2W5	Carstairs-Crossfield	Home	64.8	7.2	90.0
S½ 1 & E½ 2 26-29W4	Crossfield, Irricana, Crossfield East	PetroGas	1696	34.5	98.0
NE¼ 14-28-1W/5	Crossfield East	Amoco	1797	36.6	98.0
10-27-31-4W5	Harmattan Elkton (Leduc D-3)	Cdn. Sup.	490	25.7	95.0
10-12-19-2W5	Hartell Black Diamond	Sun	13	.97	93.0
13-13-25-5W5	Jumping Pound, Jumping Pound West, Sarcee	Shell	566	22.4	96.2
6-23-30-28W4	Lone Pine Creek	H.B.O.G.	283	11.8	96.0
6-27-29-28W4	Lone Pine Creek	Cdn. Sup.	157	8.1	95.0
2-26-7W5	Morley	PanCanadian	18	1.24	93.5
SW¼ 27-20-29W4	Okotoks	Canterra	431	26.6	94.0
6-18-32-1W5	Olds	Amerada	389	20.6	96.0
4-21-4W5	Quirk Creek	Esso	293	13.8	95.5
NE½ 2-26-7W5	Salter ²	Phillips	120	3.2	97.1
SE¼ 11-8-5W5	Savanna Creek, Coleman	Saratoga Proc.	389	16.3	96.0
4-6-20-2W5	Turner Valley	West-Decalta	23.7	3.2	86.0
6-16-26-5W5	Wildcat Hills	Petrocanada	177	14.4	92.5

¹Source: Derived from Gas Processing Plants in Alberta, ERCB, September 1983 (Maximum design capacity)

Every effort has been made to ensure the accuracy of these maps, at this point in time. However, due to the dynamic nature of the industry, changes to the data are to be expected and some form of monitoring data system will be established to update these maps on a regular basis.

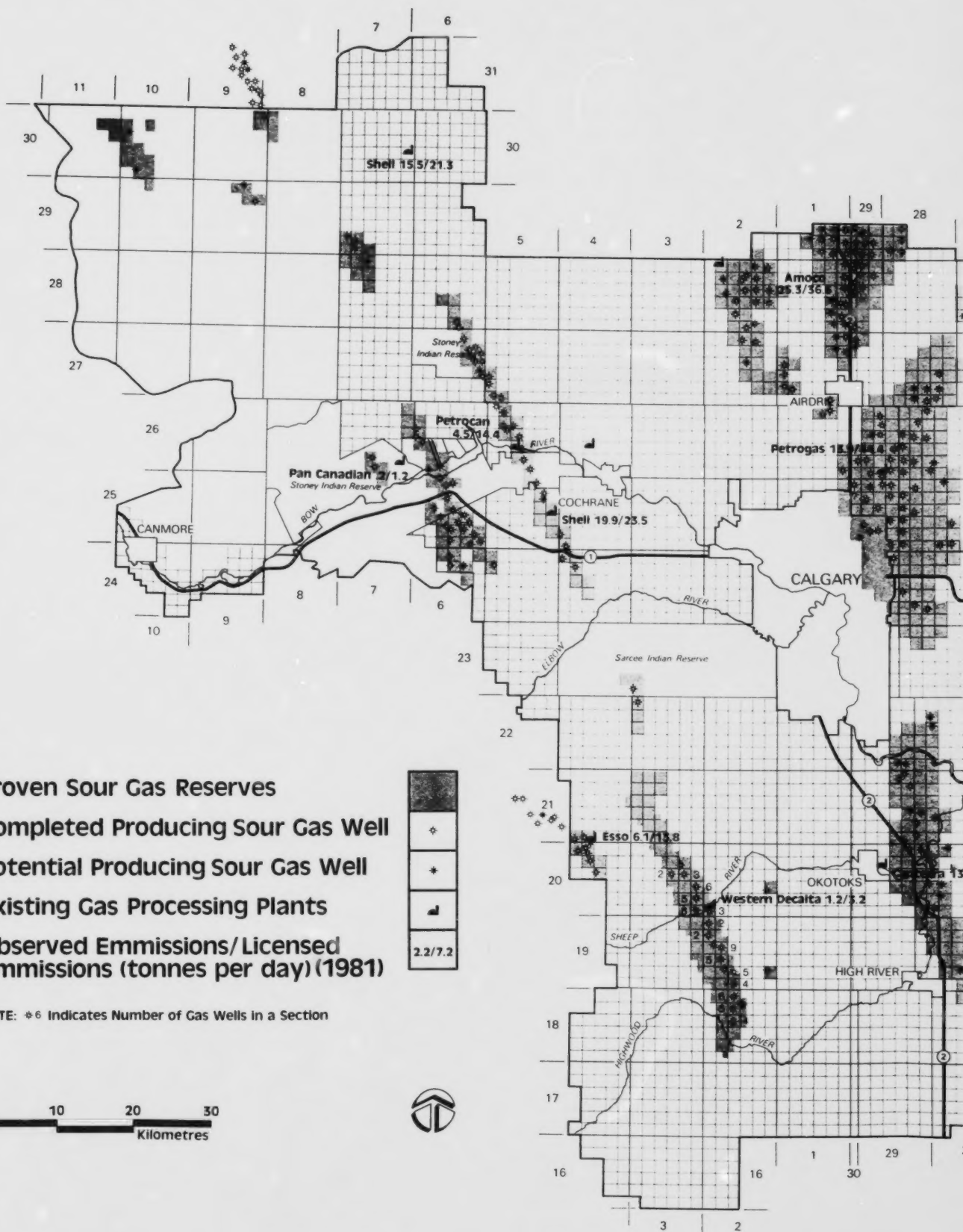
1.2.2 Existing Sour Gas Facilities in the Region

Figure 2 illustrates existing sour gas wells and plants within the Region at a small scale. Therefore, to obtain a clearer understanding of the implications of pipeline facilities for land use decisions, a series of larger scale maps of individual pools have been prepared. These maps are included in Appendix 3 of this report.

1.2.3 Sour Gas Facility Levels

The concentration of hydrogen sulphide (H_2S) in sour gas varies. The ERCB has adopted a system identifying certain levels of H_2S concentration related to sour gas facilities and their capability to release hydrogen sulphide. The Board has then devised appropriate separation distances from each sour gas facility. These guidelines are essentially the same as those contained within the Planning Act for development setbacks from sour gas facilities. Both sets of regulations are included in detail as Appendices 1 and 2 to this report. Basically, these guidelines are as follows:

- i) A Level 1 facility is a sour gas well with a potential H_2S release rate of $0.3 \text{ m}^3/\text{s}$ or less, or any other sour gas facility with a potential to release 300 m^3 of H_2S or less. A new Level 1 facility, other than a sour gas well shall have no separation distance requirement other than that associated with the easement for the right-of-way. All wells remain subject to Section 2.110 of the Oil and Gas Conservation Regulations which requires a separation distance of 0.1 km. Notwithstanding this clause, the Board may specify some other separation distance for a Level 1 facility should the circumstances warrant such action.
- ii) A Level 2 facility is a sour gas well with a potential H_2S release rate of more than $0.3 \text{ m}^3/\text{s}$, and less than $2.0 \text{ m}^3/\text{s}$, or any other sour gas facility with a potential to release more than 300 m^3 and less than 2000 m^3 of H_2S . A new Level 2 facility shall be situated to provide 0.1 km separation distance between it and any permanent dwelling, and 0.5 km separation distance between it and any urban centre or public facility.
- iii) A Level 3 facility is a sour gas well with a potential H_2S release rate of more than $2.0 \text{ m}^3/\text{s}$ and less than $6.0 \text{ m}^3/\text{s}$, or any other sour gas facility with a potential to





Sour Gas Study of the Calgary Region
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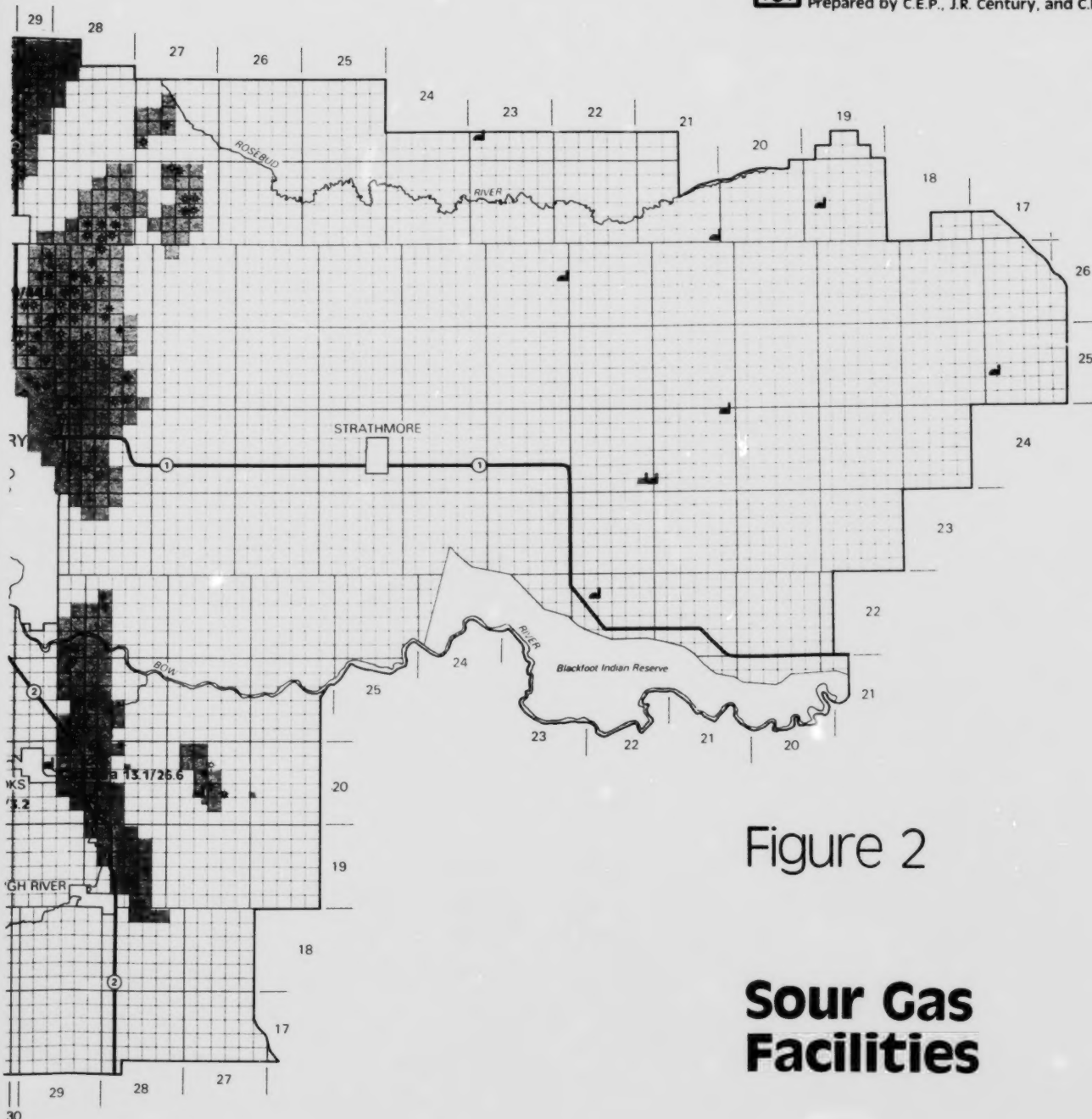
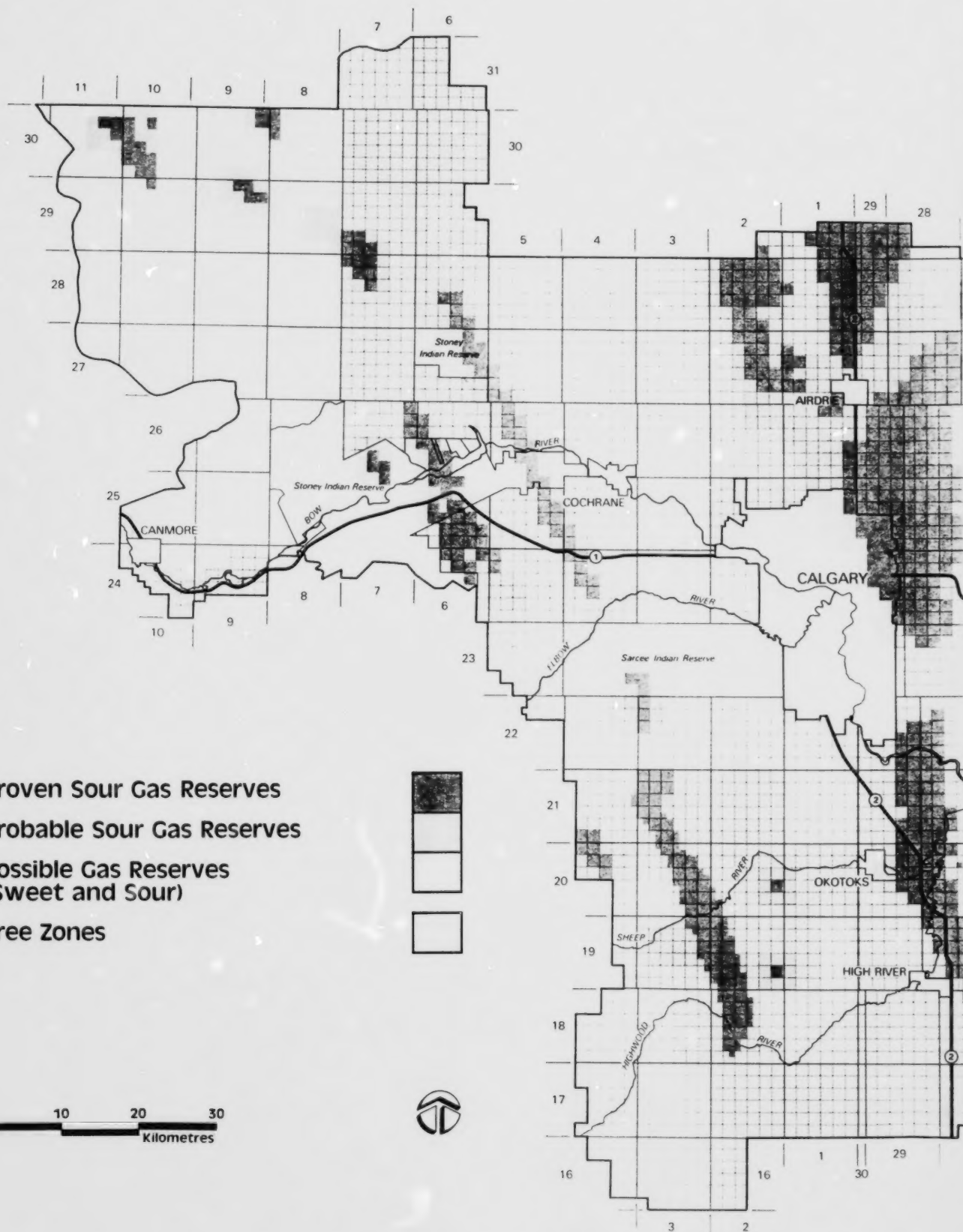


Figure 2

Sour Gas Facilities

Proven Sour Gas Reserves
 Probable Sour Gas Reserves
 Possible Gas Reserves
 (Sweet and Sour)
 Free Zones

0 10 20 30
 Kilometres





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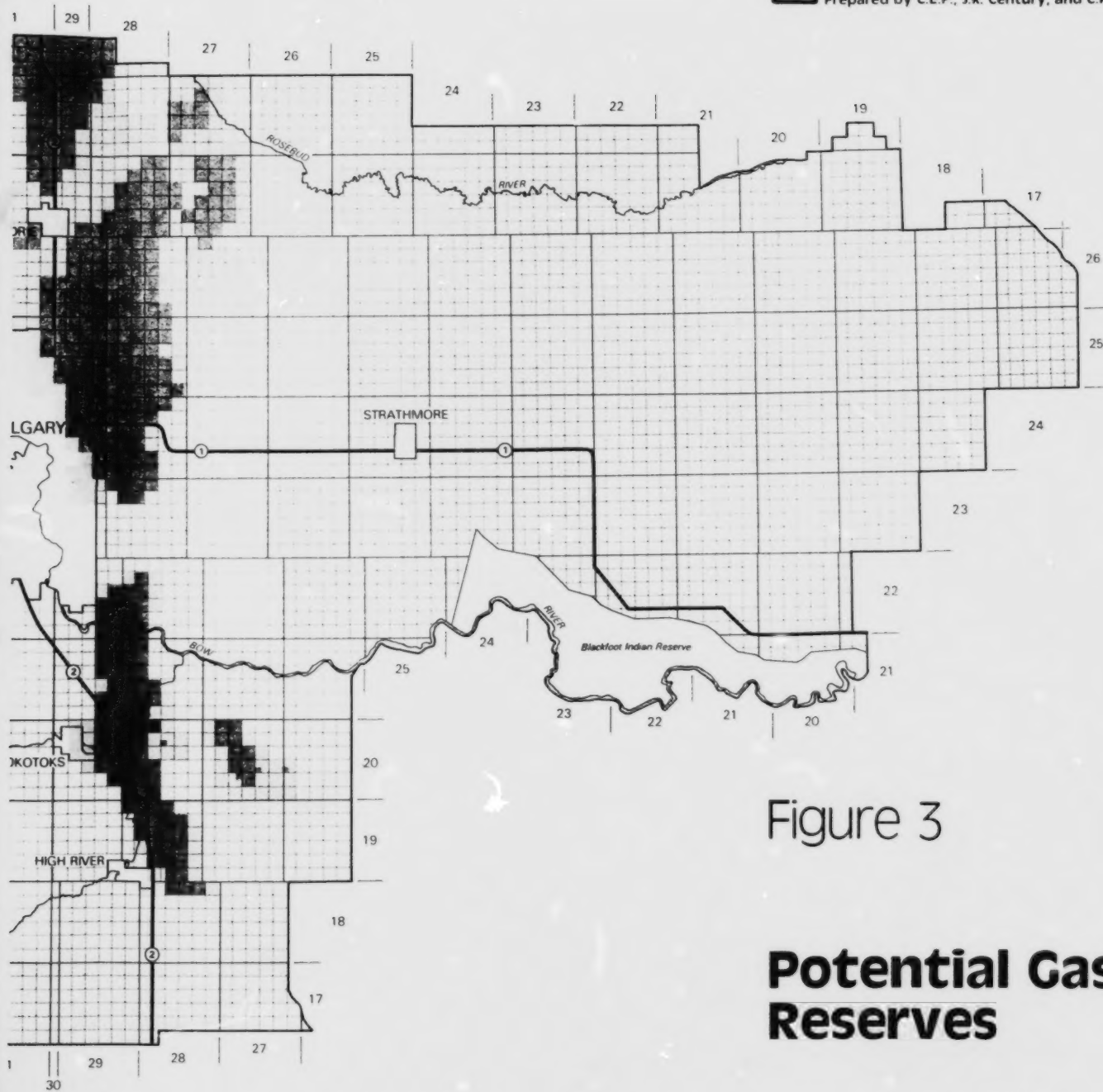


Figure 3

Potential Gas Reserves

release more than 2000 m^3 and less than 6000 m^3 of H_2S . A new Level 3 facility shall be situated to provide 0.1 km separation distance between it and any permanent dwelling, 0.5 km separation distance between it and any unrestricted rural development and 1.5 km separation distance between it and any urban centre or public facility.

- iv) A Level 4 facility is a sour gas well with a potential H_2S release rate of more than $6.0 \text{ m}^3/\text{s}$, or any other sour gas facility with a potential to release more than 6000 m^3 of H_2S . A new Level 4 facility shall be so situated that as a minimum, it shall meet the requirements set out for a Level 3 facility. However, the Board may require greater separation distances or set out other such requirements it deems necessary.

The maps in Appendix 3 show the facility level of individual pipelines.¹ This data was provided by the ERCB in November, 1983. Facility levels on wells and plants were not readily available through the ERCB and have not been included. Separation distances for pipelines, as defined by the ERCB and set down in the Planning Act are also shown on these maps. In such instances the largest separation distance that could be required, through existing legislation, has been used.² Thus, in using the maps, care should be taken to determine the nature of the proposed land use because, for many land uses, less stringent separation distances may be required. For example, if the proposed use is a country residential use rather than a public facility, then the separation distance from a level 3 facility is reduced from 1.5 km to 0.5 km.

Reference to the Planning Act, and ERCB 81-3 should be made, when reviewing a specific situation.

1.3 Potential Gas Reserves

At this level of study, the analysis of the extent of sour gas reserves has been limited to the use of pools, fields and the gas strike areas, as defined by the ERCB. The gas strike area includes areas of the Province in which gas has been tested at a significant amount.³ Shown on Figure 3 for the Calgary Region, "proven sour gas reserves" include only existing sour gas pools, (as established by ERCB), "probable sour gas reserves" include those lands inside the existing sour gas fields as established by ERCB, but outside the pool boundaries; and the gas strike areas extend beyond the existing sour gas pools and fields and are entitled "possible gas reserves". The map represents the maximum extent of potential gas reserves as known in September of 1983.

- 1 The pipeline map servicing the Shell Burnt Timber plant was not available at the time of this printing, and therefore is not included in these Appendix Maps.
- 2 Separation Distances are greatest for urban municipalities and/or rural public facilities. Refer to Appendices 1 and 2 for further detail.
- 3 Gas strike area is defined by the ERCB as being an area in which gas has been tested at rates greater than $0.56 \times 10^3 \text{ m}^3/\text{d}$ (20 mcf/d) prior to September, 1979, and $1.0 \times 10^3 \text{ m}^3/\text{d}$ (35 mcf/d) after that date.

The data source for gas strike areas does not however specify whether the gas strike area is sweet or sour. This can be established by reviewing individual well data in the gas strike area. However, such an analysis is beyond the scope of this study. A refinement of the information would, however, give a more precise basis for potential sour gas reserves in the Calgary Region. In the absence of additional study, the gas strike area is used to denote possible gas reserves for planning purposes without distinguishing between sweet and sour.

Areas of the Region which lie outside of proven, probable and possible reserve areas, are described as "free zones" and are shown on Figure 3. This term denotes areas which do not appear to be affected by sour gas reserves including proven, probable or possible. However, other factors may limit development and land use, such as high quality agricultural land, or ownership. In the Calgary Region, the major free zones are located to the east of the Crossfield gas field between Irricana and Dalemead; to the west of the City of Calgary, including Bearspaw and Bragg Creek; and south to Millarville and DeWinton. Other free zones are located in the Eastern Slopes and in the Kananaskis Country, northwest and west of the Regional Planning Commission's boundary.

In order to understand more fully the sour gas potential, reference to a geological cross-section is useful. Figure 4 illustrates a schematic geological cross-section through the Calgary Region.¹ This cross-section displays two distinct geological provinces; (i) the foothills structural and overthrust fold belt, and (ii) the plains area. Sour gas occurs in both of these geological provinces. Only the western portion of the plains area is currently known to contain significant sour gas reserves.

As new exploration tools develop, additional sour gas reserves can be expected to be discovered in other structural traps to the west and in stratigraphic traps to the east. The cross-section indicates the generalized location of major sour gas fields and pools in the Rundle, Wabamun and Crossfield formations, which are the major producing zones of the Region. Overlying strata contain both sweet gas and oil reserves. Northeast of the City of Calgary, gas is being produced from both the Rundle and the Wabamun formations from the Crossfield field.

1.4 Life Expectancy

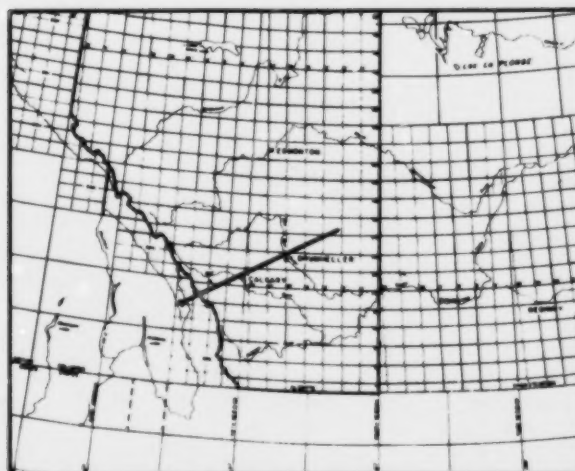
The sour gas pools in the Calgary Region have been developed since the 1920's. As a result, some areas, notably the Turner Valley Field, have been actively producing for about fifty years. In other

¹ Alberta Soc. Petrol Geol., Internat. Symp. on Devonian System-1967
Guidebook.

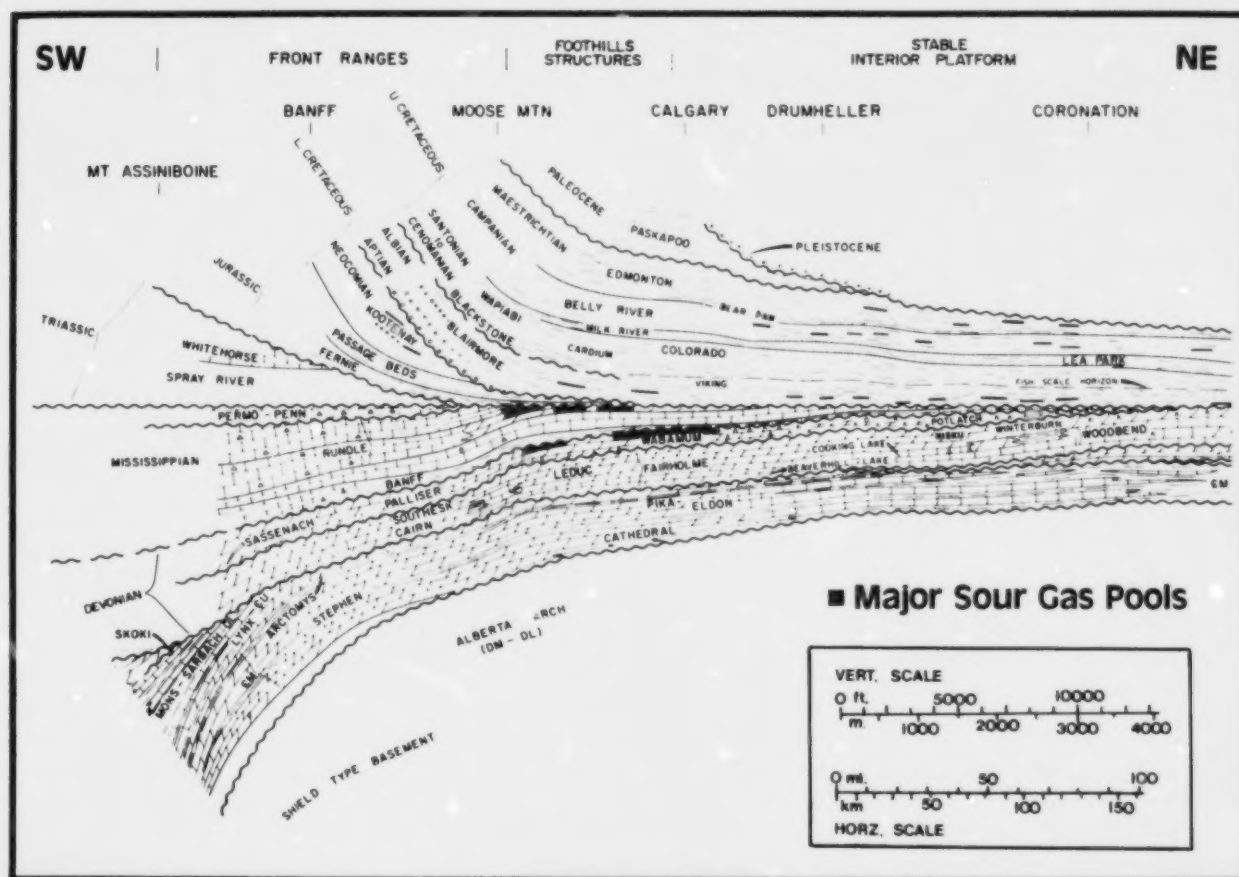
Figure 4

Geological Cross Section Calgary Region

Source: Alberta Society of Petroleum Geologists;
Development of Sedimentary Basins
in Western and Arctic Canada; 1969.



Cross Section Location



Schematic

areas, such as Quirk Creek and Mazeppa, applications for the construction of a new gathering pipeline system and a gas processing plant, were reviewed by the ERCB in 1982 and 1983. Despite the historical data available, the subject of life expectancy remains difficult to address. It appears that one of the key indicators of life expectancy for sour gas development may relate more to market demand than to the age or capacity of each well or pool.

However, the future of sour gas development appears to be influenced by three major factors:

i) The continued exploration and development of reserves.

The exploration and development of proven and potential reserve areas within the Calgary Region is a dominant factor in determining life expectancy. Drilling activity and on-going applications for further facilities indicate that exploration and development by the sour gas industry will continue.

ii) The demand to continue to produce gas from known reserves.

Gas production is largely a function of market and demand. Providing there is a need and a market for Alberta natural gas, continued production from existing reserves will occur.

iii) The Regulations applied by ERCB and Federal Government.

The market for Provincial gas is determined by the ERCB, and production is regulated in accordance with a production plan for each pool. The price of natural gas is established by agreement between Provincial and Federal Governments, relating to export sales and demand. The Board anticipates that, despite the recent decline in demand, that this is a short-term situation and that the U.S. export market will increase in the near term.

Projected sulphur production can be related back to the anticipated volume of sour gas production. However, it should also be noted that sulphur production is also related to the concentration of H_2S within the sour gas being processed. The Calgary Region is located within or in close proximity to approximately 30% of the present day total provincial sulphur production. By extracting information from the DeSorcy and Halladay report for the Calgary Region, the following Table 5 has been produced. This foregoing comprehensive report published by SUDIC, included economic factors such as market demand in its analysis.

Table 5
CALGARY REGION AND IMMEDIATE VICINITY¹
Forecast Sulphur Production from Established Gas Reserves
(Thousands of Tonnes per Year)

PLANT	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1998	2003	2008
Burnt Timber Shell	160	160	160	160	160	160	155	155	150	150	140	200	29	10
Carstairs, Crossfield Home	9	9	8	8	7	7	6	6	5	5	4	0	0	0
Crossfield East Amoco	400	395	365	350	335	320	305	285	265	245	220	75	0	0
Crossfield Petrogas	290	300	300	300	300	300	275	260	240	225	210	130	37	12
Harmattan Elkton Cdn Sup	75	88	99	108	78	67	17	18	19	20	22	8	3	0
Jumping Pound Shell	160	160	160	160	155	155	145	140	130	125	120	83	65	40
Lone Pine Creek Cdn Sup	22	20	19	17	16	15	14	12	11	10	9	3	0	0
Lone Pine Creek HBOG	27	28	30	32	28	40	42	43	44	47	46	14	11	1
Morley PanCanadian	3	4	4	4	5	5	5	5	4	4	3	1	0	0
Okotoks Canterra	120	120	120	125	130	135	135	130	130	130	130	110	51	19
Olds Amerada	45	45	45	44	43	41	39	37	35	32	32	20	0	0
Quirk Creek Esso	36	40	42	47	54	50	53	50	49	48	44	21	15	1
Savanna Creek Saratoga	73	73	73	73	66	60	55	49	46	40	35	20	19	19
Turner Valley West Decalta	3	3	3	2	2	2	1	1	1	1	1	1	1	0
Wildcat Hills PetroCanada	35	30	28	25	22	19	22	24	26	27	31	15	7	7
Calgary Region Totals	1458	1475	1456	1455	1411	1376	1269	1215	1155	1109	1047	601	238	109
Provincial Totals	5160	5150	4990	4830	4620	4535	4265	3985	3740	3500	3100	1470	690	355
Calgary Region % of Province	28%	28%	29%	30%	30%	30%	30%	30%	31%	32%	34%	41%	34%	31%

¹Source: **Forecast of Alta Sulphur Production**; Sulphur Symposium Calgary, September 1983. GJ DeSorcy & H.G. Halladay, Published by SUDIC.

These results are also illustrated on Figures 5, 6 and 7:

Figure 5 illustrates the historical and forecast sulphur production from the proven sour gas reserves in the Province and for the Calgary Region;

Figure 6 illustrates the forecast sulphur production from both the proven established reserves and the potential for the Province and the Calgary Region. A high and low case of total sulphur production is shown depending on the quantity of gas processed with higher H₂S concentrations, amongst other factors.

Figure 5
Historical and Forecast Sulphur Production*



Figure 6
Forecast Sulphur Production from Proven and Potential Reserves*

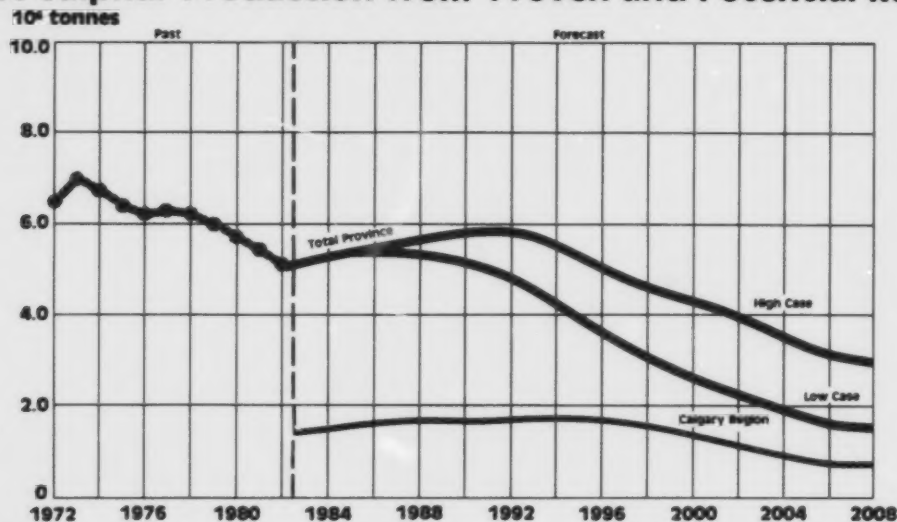
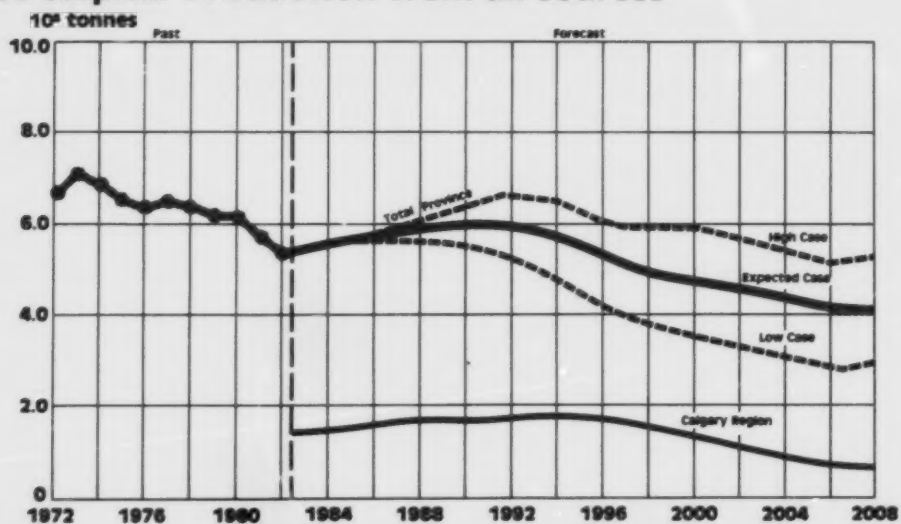


Figure 7
Forecast Sulphur Production from all Sources*



*Source: A Forecast of Alberta Sulphur Production; 1983; G.J. Desorcy & H.G. Holladay - E.R.C.B.

Figure 7 illustrates the total forecast of sulphur production from all sources from the established reserves, future reserves and oil sands. This figure also includes a high and low forecast and the "Expected Case" forecast for the Province. The expected production level for the Calgary Region is also shown.

These illustrations indicate that the projected sulphur production, and therefore sour gas production, in the Calgary Region may be expected to peak in the 1990's and decline slowly thereafter.

1.5 Conclusions

The sour gas industry is an extensive and significant economic force in the Calgary Region. The extent of proven reserves and actively producing pools and operations has increased over the past thirty years. New plants and gathering systems in areas of the Region are being proposed and constructed.

These known sour gas reserves are concentrated in the central and west portions of the Region and possible gas reserves, as denoted by gas strike areas, suggest that the future impact of sour gas development will likely increase.

Forecasts of sulphur production for the Calgary Region indicate that demand for sour gas and its products will peak in the 1990's and that the present level of production will increase until that time. Beyond the 1990's, production is forecast to decline, however, sour gas will continue to play a significant role in the Region.

2.0 SOUR GAS DEVELOPMENT THE LEGAL FRAMEWORK

There are two major pieces of legislation which govern sour gas development within Alberta. These are:

- i) The Energy Resources Conservation Act - 1980; and
- ii) The Oil and Gas Conservation Act - 1980.

Other legislation affects the oil and gas industry to a lesser degree when discussing land use impact, that is, the Land Surface Conservation and Reclamation Act and the Pipeline Act.

2.1 The Energy Resources Conservation Act - 1980

The Act created the Energy Resources Conservation Board re-naming the pre-existing Conservation Board and modifying the powers and responsibilities of the Board.

In summary, the purpose of the Act, through the ERCB, is as follows:

- i) to appraise energy reserves and the production capacity of energy resources and energy in Alberta;
- ii) to determine the local Alberta and the external, energy market demand for Alberta energy resources and energy;
- iii) to conserve the energy resources of the Province and prevent waste;
- iv) to control pollution and to conserve the environment in the exploration, processing, development and transportation of energy resources and energy;
- v) to set and ensure observance of standards for safe and efficient exploration, processing, development and transportation of energy resources and energy;
- vi) to compile and maintain a data bank of energy resources in Alberta; and
- vii) to provide up-to-date information on energy resources and provide for agencies from which the Provincial Government may receive information, advice or recommendations.

The important issues in this list, for the purpose of this report, are that it is the mandate of the Board, throughout the Act, to "conserve" energy resources and the environment. Conservation is defined as:

"planned management of a natural resource to prevent exploitation; destruction; or neglect".¹

¹ Webster's New Collegiate Dictionary.

By means of the Energy Resources Conservation Act, the Board is empowered to make inquiries and investigations, and make recommendations to the Lieutenant-Governor in Council on measures the Board deems essential to the public interest. This may take the form of rules of practice; holding inquiries; listening to any member of the public who is affected by oil and gas development; orders on proceedings; and recommending actions or studies to be undertaken within a specific time.

The authority of the Board, through the Act, is wide-ranging in matters of setting policy and procedures for the industry, providing that such actions can be shown to be in the public interest.

2.2 Oil and Gas Conservation Act - 1980

The purposes of the Oil and Gas Conservation Act are similar to the Energy Resources Conservation Act, in its intent to conserve and prevent waste of natural resources. However, this Act deals specifically with the oil, gas and crude bitumen resources of Alberta.

"The purposes of this Act are:

- i) to effect the conservation of, and to prevent the waste of, the oil, gas and crude bitumen resources of Alberta;
- ii) to secure the observance of safe and efficient practices in the locating, spacing, drilling, equipping, completing, reworking, testing, operating and abandonment of wells and in operations for the production of oil, gas and crude bitumen;
- iii) to provide for the economic, orderly and efficient development, in the public interest, of the oil, gas and crude bitumen resources of Alberta;
- iv) to afford each owner the opportunity of obtaining his share of the production of oil or gas from any pool or of crude bitumen from any oil sands deposit;
- v) to provide for the recording and the timely and useful dissemination of information regarding the oil, gas and crude bitumen resources of Alberta; and
- vi) to control pollution above, at or below the surface in the drilling of wells and in operations for the production of oil, gas and crude bitumen and in other operations over which the Board has jurisdiction".¹

¹ R.S.A., 1970 c.267 s.5; 1979, c.56 s.2-Oil and Gas Conservation Act-1980

In order to fulfill the purpose and intent of the Act, the ERCB is empowered to carry out the following actions:

- i) It may make regulations on: the information to be submitted with any application for well drilling; well abandonment; the resumption of activity; start-up of liquid injection; the spacing of wells; signage; the use and removal of equipment; methods to be used; prescribing of production rates; reporting methods; and the establishment of an information registry of all energy resources and facilities.
- ii) The Board may issue licences relating to well drilling, injection and producing operations for oil, gas and crude bitumen and provides for referral to agencies such as the Provincial Department of Alberta Energy and Natural Resources, or Alberta Environment.
- iii) In terms of oil and gas production the ERCB can designate the field and restrict the amount of production, that is, establish a production plan. This may be achieved by fixing the amount so as not to exceed the market demand for the product. Production is allocated among the various pools, and the Board fixes the quantity to be produced from each pool. The ERCB provides for equal opportunity by distributing that quantity equitably among the wells in each pool.

2.3 Land Surface Conservation and Reclamation Act

The Land Surface Conservation and Reclamation Act regulates the reclamation of disturbed land. Regulated surface disturbances include pipelines greater than 150 mm in diameter and greater than 16 km in length.

The Act, administered by Alberta Environment, requires proponents of regulated surface disturbances to prepare and submit applications for a development and reclamation (D & R) approval. The Land Conservation and Reclamation Council reviews the application. D & R approvals are usually required by the ERCB before a permit or license for a pipeline development can be issued.

An applicant is required to prepare a development and reclamation plan in order to ensure that the disturbed land will be returned to a state that will support plant and animal life, or that will be at least as productive as before it was disturbed. The applicant's plans must meet specified criteria and are to include an analysis of the site, surface, hydrology and overburden, and a land use plan, a post land use plan, and materials handling and revegetation plans. Plans submitted for approval are processed by the Land Reclamation Division of Alberta Environment, which circulates the plans to various government agencies for comments before the Land Conservation and Reclamation Council issues an approval.

Wells, batteries and processing plants are also subject to the provisions and regulations of this Act. Before an operator can abandon

these operations or surrender a surface lease, it must obtain a Reclamation Certificate. Field inspectors from Alberta Environment and Alberta Energy and Natural Resources monitor the reclamation process on site.

In addition, the Minister of Environment, at his discretion, may also require that an Environmental Impact Assessment accompany a major development application.

2.4 Pipeline Act

The Pipeline Act identifies the ERCB as the approval authority for all pipelines within Alberta, with the exception of those pipelines exempted under Section 2 of the Act. As approval authority, the ERCB issues permits to construct pipelines and licences to operate pipelines within Alberta.

It is the mandate of the ERCB, under this Act, to review applications for permits whether to construct or operate a pipeline. Applications are assessed under the following headings:

- i) general location of proposed pipeline; and
- ii) location of proposed pipeline relative to:
 - other pipelines
 - roadway development
 - transportation improvements
 - urban development
 - landform
 - structural or engineering details of the pipeline
 - comments of Provincial or local authorities
 - comments of the affected landowners.

The ERCB decision to refuse or grant a permit or licence is final and there is no appeal process in place.

The ERCB also has the power to regulate ground disturbances undulation within 30 meters of a pipeline licenced under the Act. It may shut down any ground disturbance within the designated area that does not adhere to the requirements of the Pipeline Act or related regulations. The principal purpose of this clause is to reduce the potential for third party damage to pipelines, which is recognized as a major cause of pipeline failures.

In addition, the ERCB, through the Pipeline Act, has the power to direct the owner of a pipeline to alter or relocate the line should this be deemed necessary.

3.0 SOUR GAS DEVELOPMENT THE PARTICIPANTS

The roles and responsibilities of the participants involved in the sour gas industry are reviewed to provide an understanding of how they are presently concerned with the sour gas development process. This review will serve to identify areas where communication and interaction could be improved, specifically with respect to land use planning issues and the sour gas industry.

3.1 The Energy Resources Conservation Board (ERCB)

As stressed in the preceeding section, the role of the ERCB is one of regulation and control of the sour gas industry, as well as other energy resources. Control is achieved by administering standard rules of practice, issuing licenses for drilling and pipeline operations, preparing and administering marketing and production plans, and conducting inquiries when deemed necessary to review applications for energy development.

The powers and activities of the ERCB have a very direct impact on the industry. The Board's mandate deals primarily with the wise and judicious extraction of the natural resources of oil, gas and crude bitumen. However, because the Board has such wide powers to address numerous issues related to the industry, it has become the public forum for discussion of the environmental issues of sour gas development. Typically the concerns have consisted of four major areas as follows:

i) Health

Health issues related to the sour gas industry have generally been centred on the release of pollutants by sour gas processing facilities, particularly processing plants. Health issues have had an especially high profile in the possible areas surrounding the Shell/Waterton and Gulf/Pincher Creek plants, where controversy continues to centre around the effects these processing plants have on the health of surrounding residents.

Studies have been completed in the health area, but it is generally agreed that more research will be required before any overall conclusions and related progress can be made.

Figure 2 on page 10 illustrates the location of sour gas plants in the Region. The amounts of sulphur emissions are also shown in tonnes per day. The first figure is the actual observed amounts, and the second figure, in parentheses, is the licensed amounts of sulphur allowed to be emitted from the plants in the Region.¹

¹ Source for emissions: Alta. Environment Pollution Control Division, Industrial Sulphur Emissions for Alta 1979 - 1981. (Data as shown on Figure 2 is 1981 emissions)

The public profile of health issues related to sour gas development has also been dramatically heightened by the recent inquiry into the November, 1982 Lodgepole well blowout. Here the issue is related not to emissions from gas processing but to the actual concentrations of hydrogen sulphide in the atmosphere as a result of the blowout, and the harmful effect this could have on human health. Concern is also centred around the possible harmful effects of hydrogen sulphide on livestock and soils, and actions of agencies regarding emergency area evacuation procedures.

ii) Soil Acidification

Some interveners at Board hearings also have contended that sulphur dioxide emissions from sour gas plants either have, caused or will cause, increased acidity in the soil. This, they claim, will damage the soil and reduce its productivity. Again, at present, there is inconclusive evidence and insufficient research completed to indicate whether this is a potentially serious problem and if further limitation is required on sulphur emission from plants. However, Alberta Agriculture has indicated that the buffering capacity of the soils in the Calgary Region is high.

iii) Livestock Diseases

Submissions have been made to the ERCB by various groups alleging that sulphur dioxide emissions from sour gas plants suppress the uptake of selenium by vegetation, and that this effects the selenium intake by livestock. To date, the Board has found that there is inadequate evidence to demonstrate that this is a legitimate issue. In-depth research and comprehensive investigation is again required.

iv) Acid Rain

Acid rain is generally caused by a high concentration of sulphur and nitrogen in the atmosphere. The standard pH for acid rain is 5.6. Generally, the water bodies of southern and central Alberta have a very high buffering capacity for acid rain but lakes which lie on the Canadian Shield are potentially more susceptible to this problem. The problem, therefore, relates more to emissions from northerly oil sands plants.

In 1982, as a result of hearings on applications related to the Jumping Pound and Quirk Creek sour gas processing plants and the Moose and Whiskey sour gas reserves, a general report on environmental issues respecting sour gas operations was prepared. The report "Sour Gas Processing in Alberta" reviews the evidence presented at the hearings on gas plants and pipelines where these issues were raised. It summarises the findings of the Board's inquiries and presents its conclusions. The conclusions reached by the ERCB are contained in Appendix 4 to this report.

The efficiency of sulphur recovery processes has also been questioned at these hearings and others, in response to the environmental issues. The Board's approach has been to require the best practical technology. This does not ensure the reduction of SO₂ emissions to the minimum, but takes into account the economics of sulphur recovery and the selling price of that sulphur. In essence, no change to current ERCB guidelines and practice of 97.5% average sulphur recovery was recommended by the Board in this report.

These ongoing environmental issues have put such concerns into a sharper public focus, particularly for the property owners and residents in sour gas pool areas, where the industry is continuing to develop and expand operations. Consequently, a high degree of public attention has been drawn to the various aspects and possible impact of sour gas development.

The powers of the ERCB are wide and comprehensive with regard to regulation of the sour gas industry but do not extend to land use matters. In recent years at inquiries, however, the ERCB has heard more evidence and comment from interveners on environmental and land use issues. The Board can and does comment on the technical and economic merit of an operator's proposal but not on the land use implications of that decision.

With respect to land use, there is informal interaction between the ERCB and CRPC. The Board advises the Region of industry activity and forwards notices of inquiry hearings. In turn, the Region circulates subdivision applications to the ERCB for information and comment. As per Section 11.1 of the Subdivision Regulation to the Planning Act, the Board, when contacted, is required to provide comments to the Region on an application. The Board's comments pertain to the classification of the sour gas facility, that is, whether it is a Level 1, Level 2, Level 3, or Level 4 facility, minimum separation distances and any other matter relating to public safety. The Board does not, however, render opinions or appear at Regional Planning Commission meetings where the elected officials are deliberating on general growth policies or annexation proposals. The Board does not feel able or qualified to respond on land use planning matters. Similarly, at ERCB inquiries, regional and local area planners are generally absent because they feel they do not have the expertise to examine evidence dealing with the sour gas industry.

In recent years, the ERCB has called upon the CRPC for assistance in determining the land use impact of sour gas development proposals. In order to be able to respond fully, the CRPC initiated this study. The information contained in this study is a major step forward in increasing land use planners' understanding of the sour gas industry. Regional and local planners will therefore become better qualified to address land use concerns as they relate to sour gas development.

3.2 The Calgary Regional Planning Commission (CRPC)

The Calgary Regional Planning Commission is responsible for the guidance and development of land use policy within its area. This takes the form of:

- i) the Regional Plan, a land use policy document;
- ii) subdivision approval authority for certain areas of the Region;
- iii) technical assistance and advice to rural and urban municipalities within the Region; and
- iv) encouraging public participation in the planning process.

As part of the Calgary Regional Plan land use policy, the natural resources of the Region are protected as follows:

- "i) Municipalities, in their planning documents, should protect areas of known potential resource utilization.
- ii) When identifying areas of known potential resource utilization, municipalities should consult with appropriate Provincial departments.
- iii) When examining subdivision and development applications, the subdivision approving authority and municipalities should not permit subdivision and development which might prejudice the possible extraction of known potential resource utilization.
- iv) For those natural resource extractive industries which are not exempted from the Planning Act or regulated by the Provincial Government, municipalities should ensure that plans for land reclamation accompany development applications for resource extraction.
- v) When examining proposals for resource extraction, municipalities should ensure that land, vegetation and topsoil disturbance and the potential for erosion is minimized. As well, developments should be buffered from adjacent uses."¹

In common with the policies of other regional planning commissions, which are summarized in Appendix 5, these provisions are aimed at recognizing the non-renewable nature of these resources and the need to protect their potential development, while acknowledging other land uses and development. Whenever possible, provisions and policies of the Regional Plan aim to protect or restore visual and physical conditions of the land.

The nature of resource extraction is typically long term. That is, it will generally continue over many decades. Thus, while it is regarded as a temporary use, resource extraction may be present over a lengthy time period.

¹ Chapter 4, Section 14, Calgary Regional Plan, 1984.

3.3 Local Municipalities

The Calgary Region contains four rural municipalities and twenty-two incorporated urban centres. These areas are obliged to prepare a General Municipal Plan when they are a city, town, new town, village or summer village having a population of 1,000 or more, or a county or municipal district having a population of 10,000 or more.¹ Such a document provides for the future land use development of the community, and may also include consideration of other planning issues such as the social and economic development of the community. The General Municipal Plan is aimed at guiding land use at a general level over the long term. It is accompanied by the Land Use Bylaw, which acts in a more regulatory fashion defining, for example, land use districts, permitted and conditional uses, and development setbacks. Within the guidelines of these documents, the council of the municipality is able to make decisions respecting applications for subdivisions, development permits and/or change of land use.

The local municipalities can also be granted subdivision approving authority within the Calgary Region. The City of Calgary, the Municipal District of Rocky View and the City of Airdrie presently have subdivision approval authority for their municipalities.

With respect to the sour gas industry, all local municipalities have the authority to grant approval for a development permit for a sour gas processing plant. Approvals for pipelines, wells or batteries are, on the other hand, exempt from the regulations and the provisions of the Planning Act.²

Each of the urban and rural municipalities are affected differently by sour gas development. Present procedures and policies of the four rural municipalities are summarized below.

The General Municipal Plan of the M.D. of Rocky View has mapped known and potential sour gas reserves. The policies in the plan related to sour gas state "where sour reserves and facilities are known, proposed developments are subject to the Subdivision Regulation and review by the ERCB."³

The Town of Canmore and Improvement District No. 8 General Municipal Plan 1978 has addressed sour gas as follows: "the development of sour gas fields should proceed cautiously so that no public safety hazard is created."⁴ A General Municipal Plan update is currently in progress for this area.

¹ R.S.A., 1980, c. P-9, s. 61 - Planning Act, 1980.

² R.S.A., 1980, c. P-9, s. 3 - Planning Act, 1980.

³ Section 5.1.14, Rocky View General Municipal Plan, 1983.

⁴ Sections 4.4.2.1(f) and 8.22(e), Town of Canmore and Improvement District No. 8 General Municipal Plan 1978.

The County of Wheatland, a largely agricultural municipality, has recently prepared a new General Municipal Plan. Sour gas has not been a major concern to date, because there are no proven sour gas reserves in the County.

A General Municipal Plan is currently being prepared for the M.D. of Foothills, which may present an opportune time to include policies respecting sour gas development and land use.

Within the M.D. of Foothills, the towns of Okotoks and High River are examples of municipalities that have had a referral mechanism with respect to development permit applications with sour gas facility operators. This was initiated by industry, the ERCB, the CRPC and the municipalities during 1981-1982 because of the proposal by Canadian Occidental for a processing plant in the Mazeppa sour gas field. The towns of Okotoks and High River are in close proximity to a major sour gas field which contains a relatively high concentration of sour gas facilities, and have sour gas pools with concentrations of H₂S in the 22% to 35% range.

In absence of specific information or local planning policy, the municipalities generally rely on the expertise and advice of the Calgary Regional Planning Commission.

3.4 Landowners/Developers

When a subdivision or development is proposed, the owner or developer applies to the appropriate agency for the necessary permits and then develops the land.¹

In the Calgary Region where a subdivision is proposed, the applications will be reviewed and decided by the subdivision approving authority. These are:

- i) the City of Calgary, for all land within the City limits;
- ii) the M.D. of Rocky View for land within its district limits effective January 1, 1984;
- iii) the City of Airdrie, for all land within the City limits; and
- iv) the CRPC for the balance of the land inside the Calgary Regional Planning Commission's jurisdictional area.

¹ In the planning process, subdivision refers to the splitting up of a parcel of land into smaller lots and is subject to approval by a designated subdivision approving authority. Development refers to the carrying out of any building, on or over land or the making of any material change in the use or intensity of the use of any building or land. Approvals for development are granted by all local councils in the Region, subject to meeting the requirements of the local land use bylaw.

Where no subdivision is involved, the owner/developer may approach the local municipality for the necessary development and building permits and/or change of land use classification approval in accordance with procedures established in the local land use bylaw. This system of land use control takes into consideration the present land use, existing zoning and the suitability of the property to accommodate the proposed development. Where the location of sour gas reserves or facilities is known to be in conflict with the owner's proposed development, then the regulations of Schedule 6 of the Planning Act may be put into effect.¹

However, information pertaining to potential sour gas reserve areas and proposed sour gas facilities is not always readily available to the particular approving authority. Approvals for land use change or development permits may be granted in absence of this information. Unknowingly then, the plans of surface owners may conflict with the sour gas industry. On the other hand, affected operators can find out about pending development approvals through posted notices in the paper, but feel that by the time such notices appear, there is only a limited opportunity to influence the decision.

Presently in the Calgary Region, generally only the operators in the Mazeppa and Okotoks fields and those located within the M.D. of Rocky View are advised of development matters earlier in the approval process. Development applications, upon receipt, are circulated by the municipalities to the respective operators. Operators in this area have indicated that development application decisions tend to be based on access to public roads and power, and availability of schools, etc. They feel that the importance of the sour gas industry is overshadowed and to some extent overlooked by the local municipalities in the development approval process.²

The property owner may develop his land within the provisions of:

- i) the Planning Act and Subdivision Regulations;
- ii) the Regional Plan;
- iii) the local General Municipal Plan; and
- iv) the local Land Use Bylaw,

or such changes to these documents that may be requested and approved from time to time.

¹ Development permits are not bound to these regulations.

² Reference. Personal communication - sour gas operators within the Calgary Region.

In areas affected by sour gas, little attempt is apparently made to assess the various factors concerning sour gas while reviewing a development or subdivision application. For that matter, little guidance has been given in the past to the decision-makers at any level of the approval process on sour gas aspects.

Thus, while the economic significance of the sour gas industry is acknowledged in Provincial and Regional policy, that importance has no counterpart or support in land use planning and decision-making on a day-to-day basis.

While informal referral mechanisms may be in use in portions of the Region, the system remains ineffective and is not widely used in resolving sour gas and land use conflicts. The means to redress this problem should not remove the landowners' privileges with regard to surface development, but should give proper attention to the safety setback distance requirements and economic significance of the sour gas industry.

3.5 Sour Gas Operators

The duties and responsibilities of the operator are defined by the Energy Resources Conservation Board. There is a comprehensive approval and operations system in place, administered by the ERCB. The operator is required to comply with these procedures.

The operator must obtain approvals and permits for all drilling and well activity, the construction and operation of pipelines, and processing plants. The production from wells is controlled by the ERCB, and the market and price for the product is set by the Provincial and Federal Governments.

In addition, it is the operator's responsibility to ensure that his equipment operates safely and is well maintained. Once a well is drilled, the operator remains responsible for its safe operation in perpetuity.

Above and beyond such operational duties, the operator is also required by the ERCB to prepare and administer an emergency plan in the event of an accident relating to the well, pipeline or plant. This plan requires that all persons within the affected area be contacted and advised should an accident occur and be made aware of what action to take. This may include evacuation of the area. It is the operator's responsibility to ensure that all residents of the affected area can leave the area within the time safety limits of the accident. Such duties and responsibilities are enforced by the ERCB.

Conflicts between land use and the sour gas industry arise when, despite the application of controls to the industry, the surface landowners unknowingly or not and with or without the necessary permits develop their property in close proximity to an existing or proposed sour gas facility. Thus, the actions of the operator and the landowner could conflict.

Such conflicts are less likely to arise in the reverse situation because the operator is prevented by the ERCB from developing wells, pipelines and plants in proximity to existing residences or public facilities. In any event, the operator is required to obtain ERCB approval for such development. The landowner can participate in this application review process, and his objections may be heard at a public inquiry. This system provides opportunity for his objections.

3.6 Summary

- i) The ERCB has comprehensive technical powers over the sour gas industry operators.
- ii) The CRPC is responsible for co-ordinating all surface regional land use policy, but none related to subsurface use.
- iii) The local municipalities are affected by the sour gas industry in varying degrees, and some rely on the CRPC for overall co-ordination and expertise respecting land use matters.
- iv) Landowners/developers unknowingly or not have been able to get approval for development on their property in close proximity to an existing or proposed sour gas facility. This is, in part, due to the fact that the Planning Act does not require that development permits conform to setback distances specified for sour gas facilities. Such setbacks are required for subdivision approvals.
- v) The operators of sour gas facilities are required to obtain ERCB approval for all their development operations. Only with regard to the location of a gas processing plant are they required to obtain approval for a development permit from the local municipality. The operators have little opportunity to raise objections and little expectation of preventing a surface land use from proceeding.

In general terms, what is lacking is an effective method of reviewing surface and subsurface issues in a common forum where a balanced view may be reached.

In addition, understanding sour gas, what it is and where it is, and the effect it has on existing and future land use will give a greater incentive to the participants to co-operate with each other. The distribution of adequate information relating to sour gas development, land use planning policies, and application procedures to all affected parties, will help ease the problems that have arisen from ignorance of the facts and the impact of subsequent decisions.

4.0 LAND USE POLICY

4.1 Regional Policies

The first regional planning commissions were established in the 1950's. Funded by the Alberta Planning Fund, there are ten regional planning commissions in the Province. The Calgary Regional Planning Commission and the municipalities in the Region are responsible for planning matters within the Region, to ensure that all planning and development conforms with the Planning Act (1980).

The main duties of the Commission as set down in the Planning Act are as follows:

- i) the preparation and adoption of a Regional Plan;
- ii) the preparation of other statutory plans, and the provision of other planning advice upon the request of a municipality;
- iii) the review and approval of subdivision applications, except where this has been delegated to the municipality, and
- iv) the encouragement of public participation in the planning process.¹

Regional land use policy for the Calgary Region is established by the Calgary Regional Planning Commission. Such policy is contained in the Regional Plan. The Commission is made up of representatives from local councils within the Region, so that land use decisions made respect the collective view of the local municipalities. The preliminary Regional Plan was approved in 1971. This plan has been updated and revised and the new Calgary Regional Plan was ratified by the Minister of Municipal Affairs on May 9, 1984.

The Calgary Regional Plan calls for future urban growth to be encouraged to locate in existing urban centres. Such centres have some urban services such as shopping, recreation and municipal services. As such, higher densities and increased population will encourage further service development and activity.

For each urban area, an urban fringe is proposed to accommodate anticipated future growth and protect long term growth options. The exact boundary and extent of individual urban fringe areas is to be determined by the affected urban and rural councils.

The continued expansion of multi-lot country residential development into rural areas is subject to conservation policies. Such policies are aimed at protecting higher value agricultural land, and areas of environmental significance.

¹ R.S.A., 1980, c. P-9, s.26, 48 and 86 - Planning Act, 1980.

Settlement within the region is categorized for purposes of this study, within the general framework of the proposed Regional Plan and is, as follows:

i) Urban Areas

These are the existing urban parts of the Region and include towns, cities, villages and summer villages.

ii) Urban Fringe Areas

The proposed Regional Plan initially calls for Urban Fringe Areas adjacent to urban areas with the fringe size being dependent upon population size criteria; a maximum 5 mile (8 km) radius around the City of Calgary, a 2 mile (3.2 km) radius around urban areas of 1,000 - 100,000 population and a 1 mile (1.6 km) radius around centres of less than 1,000 population. Since the fringe zones of individual urban municipalities have yet to be refined, an urban fringe is only illustrated schematically around each incorporated centres in Figure 8. It should be noted that the urban fringe areas are only symbolic and not actual, when reviewing this map.

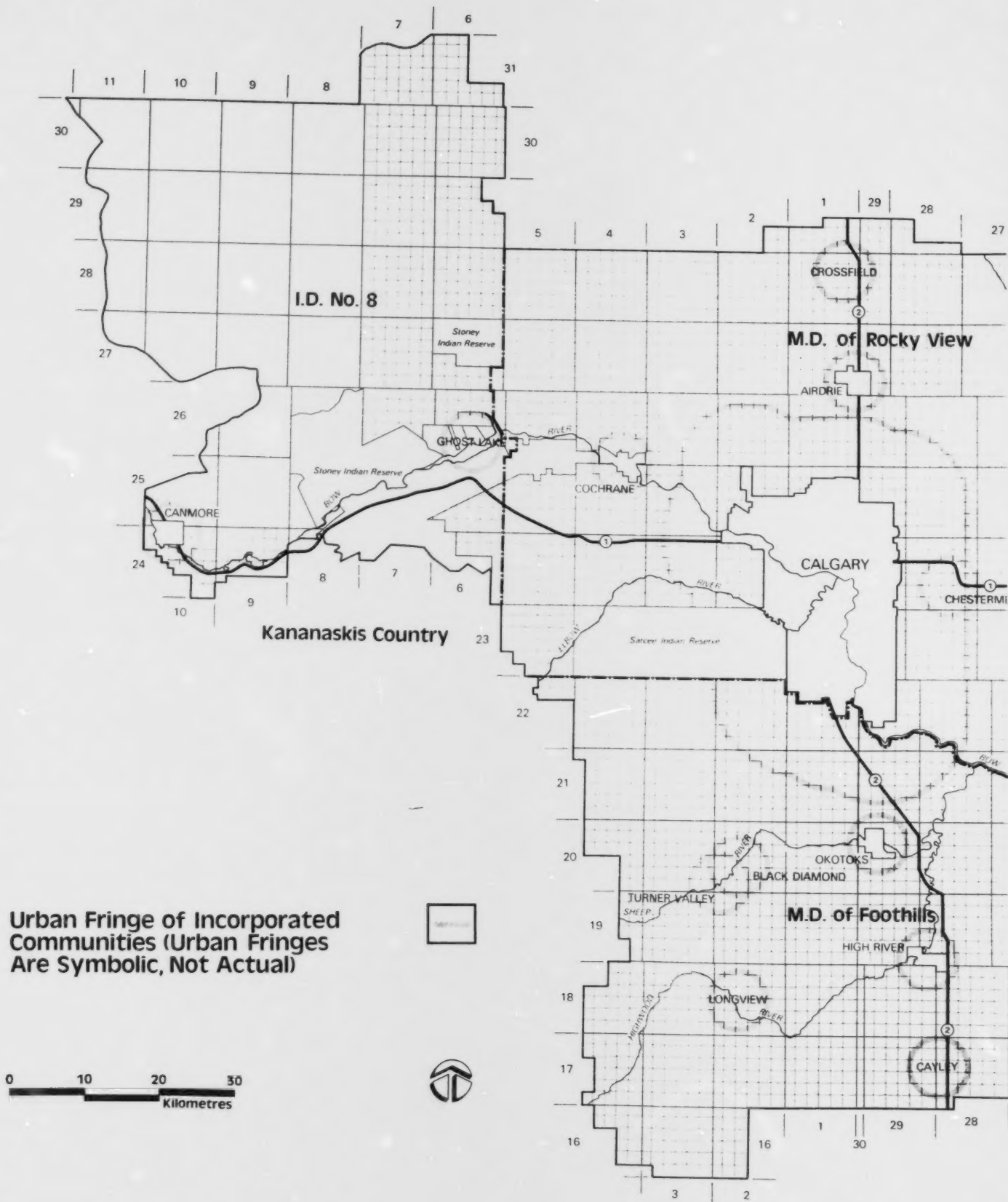
iii) Rural Areas

Rural areas contain the broadest range of general agricultural pursuits and recreational, country residential, institutional, rural commercial and rural industrial developments. Country residential development is at present the major type of development in the rural areas. In the M.D. of Foothills, this is generally south and southwest of the City, as far south as Okotoks and west to Kananaskis Country, focusing on Millarville. In the M.D. of Rocky View, country residential is more substantial and scattered to the north and west, particularly in the Bragg Creek and Bearspaw areas.

Areas of the Region where regional growth may be in conflict with the sour gas industry are described in Section 5.0.

4.2 Municipal Policy

In addition to the overall regional policies are the municipal policies. The Calgary Region consists of four rural municipalities and twenty-two urban municipalities. Municipal land use policy is contained, in most cases in the general municipal plans, and in the land use bylaws. The general municipal plan is aimed at guiding land use development at a general level over the long term. The land use bylaw acts in a more regulating fashion defining, for example, land use districts, permitted/conditional uses and development setbacks. For the purpose of this study, general municipal plans have been reviewed, where available. In the absence of an approved plan, discussions have been held with Commission staff to ascertain the general status and trends of development.





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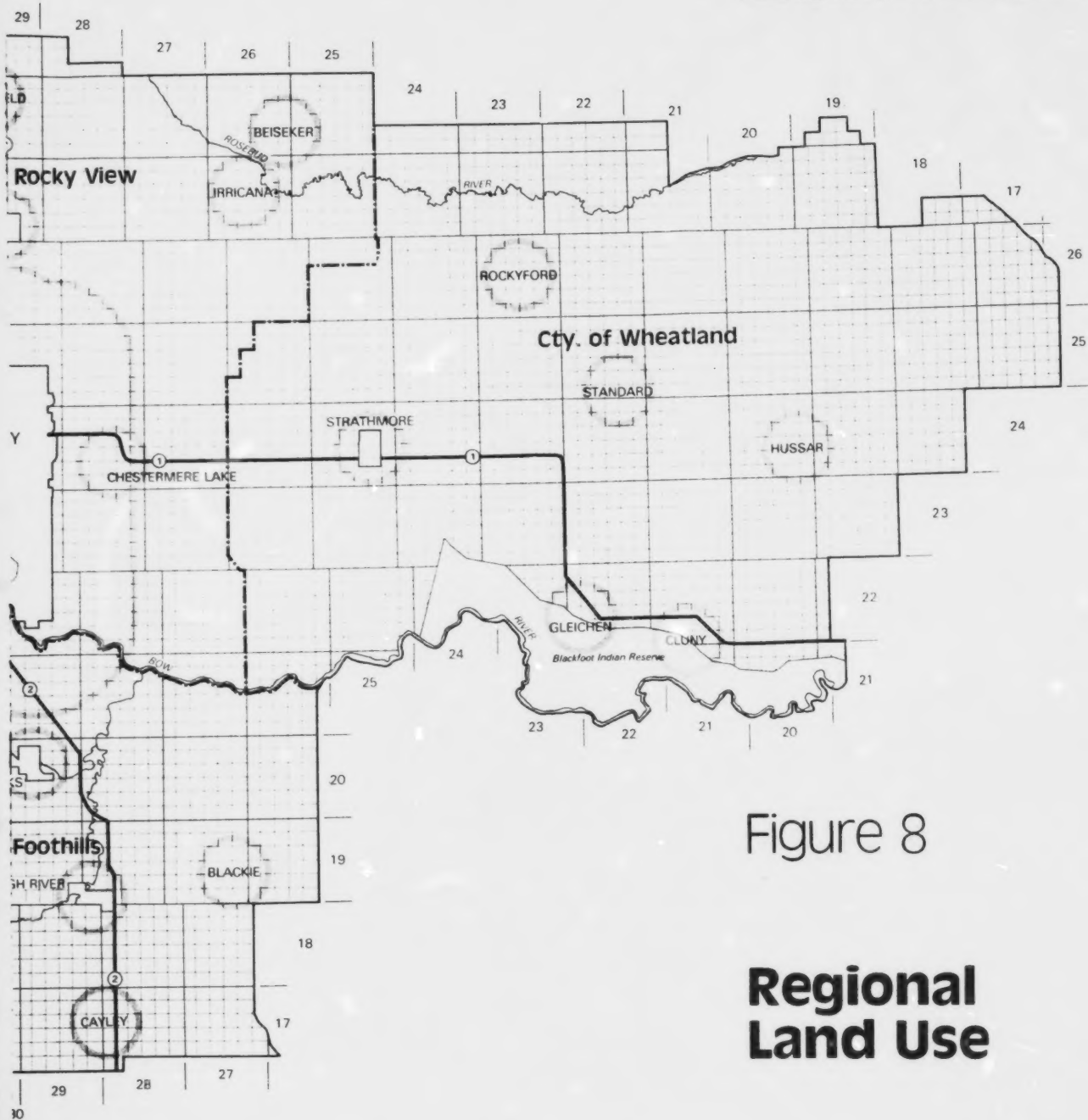


Figure 8

Regional Land Use

Because the impact of the sour gas industry may be greater within rural municipalities due to their larger areas, the planning approach and general trends at the rural municipal level have been summarized and are described below:

4.2.1 M.D. of Rocky View

The M.D. of Rocky View extends across the north part of the Region and surrounds the City of Calgary to the north, east and west.

The General Municipal Plan for Rocky View envisions rural industrial development to the north and east; while commercial developments will be encouraged in appropriate locations throughout the M.D. These could include highway commercial, hamlet retail, recreational commercial and local rural commercial. Country residential subdivisions will be provided for in any of the districts, with the exception of the Chestermere-Shepard areas. This will of course depend on the merits of each specific proposal.

4.2.2 County of Wheatland

This largely agricultural municipality, located in the eastern portion of the Region, has been experiencing pressures for recreational and industrial development. The County currently does not allow multi-lot country residential subdivisions and it is not anticipated that this will change to any major degree.

4.2.3 M.D. of Foothills

The M.D. is located south of the City of Calgary and extends to the Kananaskis Country to the west. The area contains a mixture of agricultural uses, scattered country residential development in areas within convenient commuting distances from Calgary and larger urban municipalities such as High River and Okotoks. It is expected that pressure will continue predominantly in the north and west areas of the M.D. for residential and commercial recreation development, and for some rural industrial and natural resource development in areas throughout the M.D. Agriculture will, however, continue to play a major role in land use. The continued development of larger urban centres is also anticipated.

4.2.4 I.D. No.8

The Improvement District is located in the northwest of the Region extending to the Banff National Park boundary to the west and the Ghost River district and Red Deer River to the north.

Much of this land is controlled by the Province in the form of Crown Lands. These are largely Forestry Reserve Areas, where limited recreation and resort development has occurred. To the south of this area are the Stoney Indian Reserves and the heavily trafficked area of the Trans-Canada Highway to the Bow Valley and the National Parks to the west. This area is very attractive for tourism and recreation development particularly in light of the 1988 Olympics. Resource management policies for the Ghost River District and the General Municipal Plan for I.D. No. 8, will guide future development of this district. It is anticipated that Canmore will continue to expand as the urban focus for tourism in the I.D. Large private holdings in the Bow Valley could potentially be the site of major recreation resort development, while other parts of the area will be largely protected by resource management policies which are aimed at conservation of the quality environment in much of this district.

4.3 Issues

The major issues relating to the sour gas industry and the regional and municipal planning process involve the co-ordination of present and future land use development in the Region. At present, the municipal and regional planning authorities are responsible for surface planning in the Region and the ERCB is responsible for approving the method of subsurface extraction of sour gas reserves and the related facilities required to accomplish this¹. The regional and municipal authorities, and the ERCB operate under distinct separate legislation, as discussed in Section 2.0.

The resulting separate process for surface and subsurface development has created shortcomings in the co-ordination of planning for the Region. Some initial steps have been taken to introduce communication between the responsible agencies. These have included a referral of subdivision applications to the ERCB for comment, to ensure that the application is outside the safety separation distances from sour gas facilities and also, an informal development referral system has been setup between the operators and affected municipalities in the Okotoks area. However, within an overall framework, there are still shortfalls in the planning system relating to the sour gas industry. These can be briefly summarized as follows:

¹ Exception should be noted for the approval of a gas processing plant. Approvals, under current legislation, are required from both the ERCB and the municipality.

- i) lack of an adequate data base, relating to sour gas facilities in the Region, a data base which is available to both the regional and municipal planning authorities. At present, there are no current maps, or integrated data bases, that are readily available to municipal or regional planning authorities to help ensure that they are aware of the location, extent and possible hazard of sour gas facilities.
- ii) lack of an effective referral mechanism for development matters between municipalities and the regional planning commission and, the ERCB and operators of the sour gas gathering systems. Developments may be approved without examining whether they will impact on operating sour gas facilities and, if they are outside the safety separation distances from sour gas operating facilities.
- iii) lack of communication between regional and municipal planning authorities with the ERCB and operators regarding plans for surface land use development in the Region. General municipal plans, annexation proposals and other types of planning documents are seldom circulated to the ERCB and operators in the Region to ensure they are aware of future development plans or have an opportunity to comment. It should also be noted that unless a rural municipality has a population of over 10,000 that a general municipal plan is not required.¹ This poses special problems for communication on land use planning between these rural planning authorities, and the ERCB and operators.
- iv) lack of communication between the ERCB and the operators, with the municipalities and the regional planning commission, regarding plans for new sour gas facilities in the Region. New plants, pipelines and wells are proposed and may be discussed at early planning stages with the ERCB. Often, however, it is not until the notice of hearing is mailed or placed in the newspaper that the planning authorities are aware of it. This is most often too late in the operators' planning process for the planning authorities to make a constructive contribution.
- v) lack of effective specific policy directive in the Calgary Region and in local planning documents, regarding management of natural resource (in this case, sour gas) extraction and other land uses that may be affected. To date the proposed regional plan and the general municipal plans do not have comprehensive management policies to ensure the co-ordination of sour gas extraction with other surface land uses and development plans.

¹ R.S.A. , 1980, c.P-9,s.61- Planning Act, 1980

4.4 Conclusions

The Calgary Region has experienced considerable growth and development over the past decade or more. Despite the current downturn in the local economy, it is expected that the Region will continue to develop. The need for urban expansion will be met by Regional Plan policies on Urban Fringe zones and rural development will be directed into appropriate areas of the Region.

Key to resolving the issues and shortcoming between this surface land development and the continued expansion of sour gas facility development is greater communication between the industry operators, the ERCB, the CRPC and the affected municipalities. A framework must be established so that information can be exchanged.

5.0 POTENTIAL CONFLICT AREAS

The inventory of proven, probable and possible sour gas reserves and facilities, the pattern of development within the region, and the Regional Plan policy areas (urban, urban fringe and rural) were combined to produce Figure 9. This illustrates areas where the sour gas industry has an interest, and how these areas relate to existing incorporated centres within the Region. A detailed discussion of the identified potential conflict areas form the basis of selecting appropriate management options as discussed in Section 6.0, to mitigate surface and subsurface development use conflicts.

The Potential Conflict Zones as outlined on Figure 9 represent an overall picture. More detailed analysis of each location within the zone is possible by referring to the maps in Appendix 3. Lands to the east of the City of Calgary, in the Crossfield and Mazeppa fields, are more severely affected by potential conflict, than those in the southwest and west of the Region in the Turner Valley and Jumping Pound fields. This is because of their closer proximity to urban centres and the pool's relative high concentration of hydrogen sulphide.

The Potential Conflict Zones are derived from an analysis of the proven sour gas reserves (sour gas pools), the probable sour gas reserves (sour gas fields), and possible gas reserves (gas strike areas); and the proposed regional land use policy analysis. The zones are described in four levels, as follows:

i) Primary Zones

This is applied to the lands which overlie the area of proven sour gas reserves (pools)¹ which are currently being actively produced in both urban and rural areas.

ii) Secondary Zones

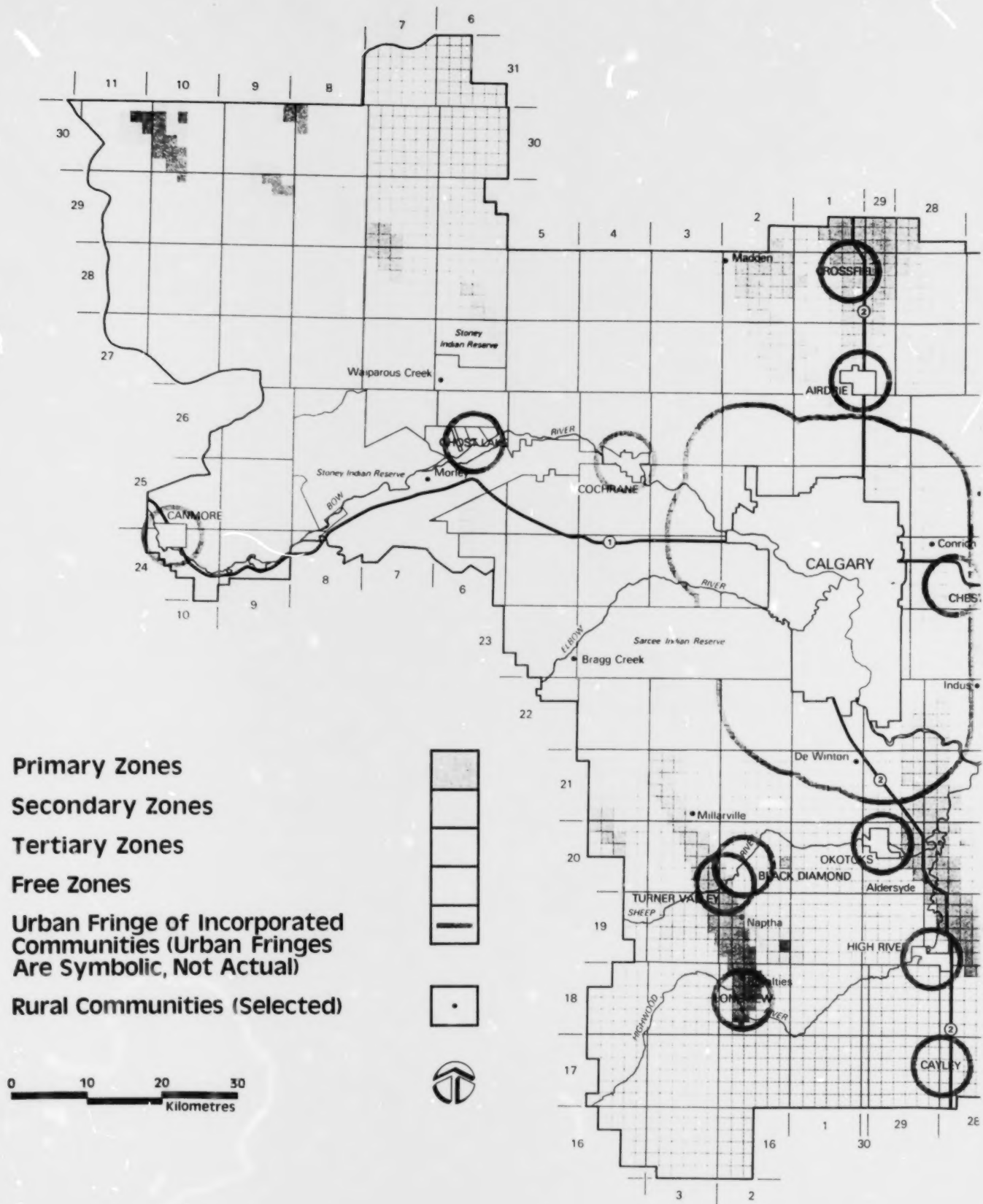
This is applied to areas where urban and/or rural development may occur and which overlie the probable sour gas reserve areas (the sour gas fields as defined by the ERCB).²

iii) Tertiary Zones

This is an area where urban and/or rural development may take place and where possible gas reserves may exist as indicated by gas strike areas. This third zone applies to the majority of the study area.

1 Sour gas pools are defined by ERCB G-orders.

2 Areas within fields as defined by ERCB F-orders, and adjacent to sour gas reserves as defined by G-orders.





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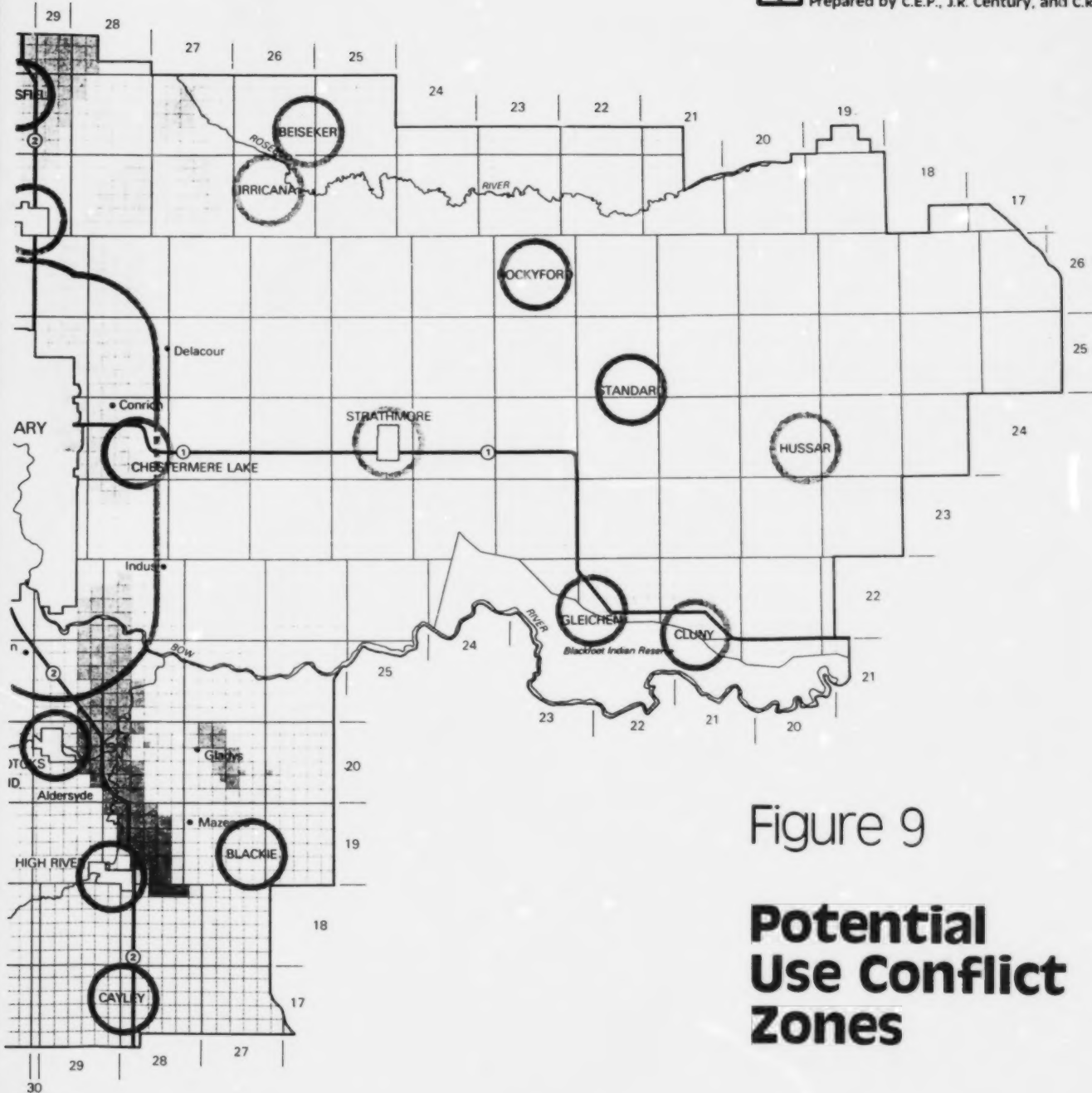


Figure 9

Potential Use Conflict Zones



It should be noted that the gas strike areas do not distinguish between sweet and sour gas. It is possible that further analysis may allow sour gas occurrences to be determined with greater certainty. Further drilling in these areas would also contribute to a better understanding of sour gas distribution in the Region.

iv) Free Zone

The balance of the land is described as the free zone where no conflict is anticipated on the basis of this study.

5.1 Primary Zone

In this zone of proven gas reserves, the fields exhibit different characteristics. Therefore the degree of potential conflict for surface development may vary. To further define potential conflict, the following factors must be considered.

i) The Level of H₂S Concentration

Sulphur content of gas from any pool varies. In the Jumping Pound and Turner Valley fields, the H₂S concentration is in the order of 5% to 10%. In contrast, the sour gas being produced from pools in the Crossfield East field is closer to 35%. The H₂S content from well to well in any one pool may also vary.

Consequently, the pipeline gathering systems in these fields reassigned different levels of facility ratings by the ERCB,¹ and as a result the separation distances for land use and development vary.

ii) Concentration of Existing Sour Gas Facilities Within a Field

When many wells and pipelines occur in a field, the impact on adjacent land uses is consequently greater and future development of the land for other uses is more difficult. The presence of an operating sour gas plant, with an anticipated long life expectancy, may have additional potential impact on these lands. This is because of:

- the size of the plant facility;
- the large investment an operator has made with an expectation of a maximum life and profit from this facility;
- the requirement for servicing, such as access roads and power; and

¹ ERCB Interim Directive ID 81-3.

- the increased impact on the general aesthetics of the area and perhaps, as felt by certain public groups, the health of surrounding residents by the release of sulphur dioxide (SO_2).

The Okotoks and Mazeppa fields are examples of fields where there is a high concentration and investment of sour gas facilities.

iii) Proximity to Urban Centres, or Rural and Country Residential Development

The proximity of certain types of existing land use is another factor which distinguishes portions of the primary zone from one another. Sour gas pools in close proximity to urban centres or denser forms of development will have greater impact. Figure 9 shows that the Crossfield field extends into the limits of the City of Calgary where intensive development has occurred. Proven sour gas reserves also underlie the communities of Crossfield, Conrich, Turner Valley, Longview, Naptha, and Royalties. Furthermore, the areas into which development may expand as denoted by the Urban Fringe policies of the Regional Plan, have also been found to overlie proven gas reserves.

Since the operator is responsible for the emergency plan in the event of a well blow-out or pipeline break, etc., the density of development and nature of the land use becomes critical. Generally, the greater the number of people in the affected area, the greater the problem is for the operator to protect the safety of these residents.

Consequently, the ERCB works to ensure that sour gas facilities which operate or produce sour gas reserves with higher concentrations of H_2S avoid existing settlement areas by means of the standard separation distances or as designated in particular cases by the ERCB itself.

This does not resolve all potential problems as municipal development permits are not required to respect separation distances as outlined in the ERCB's Interim Directive ID 81-3, or the Subdivision Regulation.

iv) Potential Facility Development

This factor takes into consideration the remaining established reserves and, to some extent, probable reserves. These dictate to some degree what additional sour gas wells, pipelines and processing facilities may be anticipated. This factor is the most subjective because there are no absolute facts or figures to project when and how this development will take place. It is an assessment made as a result of discussions and observations generated in preparation of this study. Two fields in particular illustrate this factor.

Mazeppa: Additional pipelines and wells will likely be developed to the Canadian Occidental plant at Aldersyde.

Turner Valley: New pipelines will likely be proposed to service the Western Decalta Plant.

v) Environmentally Sensitive Areas

The northwest portion of the Calgary Region lies within the area known as the Eastern Slopes. This is a resource management planning area administered largely by Alberta Energy and Natural Resources. The document which provides an overall guide for multiple resource interests, is entitled "A Policy for Resource Management of the Eastern Slopes". Subsequently, more detailed integrated resource plans have been prepared for sub areas of the Eastern Slopes region. To implement resource management objectives for this region, zones have been identified to give positive direction for future management and to identify permitted uses so as to avoid conflict between the many and diverse renewable and non-renewable resources. The zone entitled "multiple use" presently contains a number of producing gas fields such as Panther River, Burnt Timber, Hunter Valley, Benjamin, Moose, Whiskey, Quirk Creek and Wildcat Hills.

The provisions of the multiple use zone for the Eastern Slopes recognize the gas industry. Future development and exploration will be permitted, subject to compatibility with other resource considerations such as areas of high recreational value, sensitive environmental terrain and wildlife habitats.

In addition, the Calgary Regional Planning Commission staff have recently completed a study documenting Environmentally Significant Areas within the Region.

When any of the above factors are combined, such as high concentrations of H_2S in an existing developed area, the selection of management options to mitigate potential conflicts will be quite different from other areas in the primary zone that have perhaps a high concentration of H_2S , but are located in remote or environmentally sensitive areas.

The Crossfield field, located immediately east of the City of Calgary, has already had extensive impact of the potential of the undeveloped land outside the Calgary city limits. Recent annexation and development proposals which have been brought forward where sour gas is an issue include the Northridge Annexation and the Saddle Ridge Area in northeast Calgary. In both instances, the presence of sour gas in the area has posed a major constraint to development.

The City of Calgary is continuing to review the annexation potential of land adjacent to the City limits. One of the most readily available and capable areas of physical surface development from a ser-

vicining point of view, is the area east of the City of Calgary. This area coincides with the primary zone as defined by this study. The concentration of H_2S in the Crossfield, Okotoks, and Mazeppa fields is such that the required separation distances would have a significant impact upon surface land use patterns for urban density development, in addition to other environmental and safety concerns.

Primary zone mapping can serve to alert those involved with land use matters to the presence of significant and actively producing sour gas reserves. The continued economic benefit of the resource extraction industry in the local, provincial and federal realms is such that the continued protection of the resource is and should be a priority in the primary zone. Therefore, it is suggested that land use proposals be vigorously reviewed, so as not to conflict with this important natural resource.

A range of management options may be applied for the primary zone including, for example, a comprehensive referral and review mechanism, a detailed inquiry into the proposed surface development and land use policies to establish use priorities. These will be discussed in greater detail in Section 6.0 of this report.

For the most part, the review of such subsurface development is already closely monitored by the ERCB. Therefore, it is appropriate that a similar level of attention be given to surface development in this primary zone by regional and local planning authorities.

5.2 Secondary Zone

In this zone, the extraction of sour gas from probable reserves is the issue. Since these probable reserve areas are still unproven, it is proposed that the surface land use and the subsurface potential be considered to have equal priority. In order to protect both the surface and subsurface development potential, a comprehensive referral and communication system is appropriate. In this manner, the interests of all parties may be treated equally by making the necessary information available to the decision-makers and participants as early in the process as possible. The intent of the "early warning" system is to defuse potential conflict.

The secondary zone is one of probable sour gas reserves, and therefore is the zone in which drilling programs and future sour gas development should be anticipated and monitored by all participants. As displayed on Figure 9, uncertainty exists within the secondary zone. Some probable reserves are likely to be proven in the future through additional drilling, while other secondary zone areas may prove not to have sour gas reserves. Analysis is required of geological details of well information from one area to another.

5.3 Tertiary Zone

This zone occupies all land where there is potential sour gas or sweet gas reserves. The likelihood of finding or proving the sour gas resource is subsequently more remote than the secondary zone.

This area is derived from the gas strike map of the ERCB dated May 1983. The basis for the gas strike map is that if a well has been drilled and has found gas, either sweet or sour, then much of the surrounding township is included within the strike gas area.¹ Thus, given this manner of defining possible gas reserves, additional drilling would be required to prove these resources.

In terms of land use impact, it is proposed that since the resource potential is liberally interpreted, the use priority should be in favour of the surface landowner. Surface land development in this tertiary zone should proceed but with consideration of the possible future sour gas resource. Further refinement of the gas strike mapping may be appropriate, in addition to the updating and monitoring of drilling activity in this zone.

5.4 Conclusions

Sour gas reserves in the Calgary Region have the greatest impact on land use in the primary zone. Through further analysis, this primary zone should be refined to give a more precise reflection of the extent of potential surface and subsurface conflict. For example, where existing municipalities exist over proven reserves, more study will be required to establish a means of safe co-existence.

From the information contained in this study of sour gas in the Region, use priorities are recommended for each of the zones. They are as follows:

- Primary Resource extraction should be a priority because of the presence of producing pools. Surface development may continue or expand, subject to a detailed review that would establish development setbacks to ensure safety of the public.
- Secondary Surface and subsurface uses should be given equal priority to be devised through a blend of industry and land use planning policy and practices.
- Tertiary Surface land use should be given the priority with subsurface development continuing, with a referral and communication system to advise planning agencies and industry of local changes.

¹ Gas strike area is defined by the ERCB as being an area in which gas has been tested at rates greater than $0.56 \times 10^3 \text{ m}^3/\text{d}$ (20 mcf/d) prior to September 1979, and $1.0 \times 10^3 \text{ m}^3/\text{d}$ (35 mcf/d) after that date.

6.0 DISCUSSION OF MANAGEMENT OPTIONS

A number of options that could be used to address impacts of the sour gas industry on existing and future land use patterns of the Calgary Region are discussed herein.

The main premise in developing the management options is to establish lines of formal communication, information exchange and/or a forum where a balanced view can be achieved in assessing sour gas impacts on surface land use matters.

These various means of addressing sour gas impacts on surface land uses were proposed by the consultant and reviewed by the Regional Plan Committee.

6.1 Legislation

Sour gas development is largely controlled by the ERCB, through the Energy Resources Conservation Act, the Pipeline Act and the Oil and Gas Conservation Act. These three pieces of legislation enable the ERCB to regulate subsurface development in oil and gas, crude bitumen and coal. Through a system of licences, permits, specification standards and codes of practice, the ERCB has the mandate to ensure the safe and efficient extraction and marketing of the sour gas resources of Alberta.

Similarly, the Planning Act provides land use planning powers to the CRPC and local municipalities through the Alberta Planning Board and the Provincial Department of Municipal Affairs. The Regional Planning Commission establishes overall land use policy for the Region, with which all local general municipal plans and development decisions must comply.

Requirements governing separation distances between sour gas facilities and land development are enforced by both agencies. Minimum distance requirements are set out in the ERCB's Interim Directive ID 81-3, and are upheld in the Subdivision Regulation pursuant to the Planning Act, 1980.

The Subdivision Regulation only requires the Board to submit comments on subdivision applications when contacted by the subdivision approving authority. The Board advises of the classification of a sour gas facility and may make recommendations concerning safety measures and setback distances in addition to regulations specified in Schedule 6 of the Subdivision Regulation.

Unlike subdivision approvals, the Planning Act does not require development permit approvals to respect separation distances as outlined in Schedule 6 of the Subdivision Regulation. This may be an area in which change to legislation should be considered.

6.2 Regional Policy

Sour gas resources, underlying the central and western portions of the Region, affect many of the urban municipalities. Regional policy addressing potential land use impact of the sour gas resource may be considered appropriate.

Regional policy and procedures, for example, could help identify use priorities within areas affected by proven, probable and possible sour gas reserves in the Calgary Region, as well as address the need for a comprehensive information referral system.

Use priorities are intended to accommodate the land use which has the greater economic impact in that particular zone. This does not mean that all other land uses would be excluded but rather that all development should be carefully reviewed in light of the proven, probable or potential sour gas resource in the area. This may be achieved by drafting provisions in the natural resources section of the Regional Plan.

In addition, policies relating to sour gas should be extended, in a complementary and supporting manner, to other land use categories addressed in the Regional Plan such as residential, recreational and industrial uses. An additional provision in these categories respecting sour gas would ensure that its potential impact is not overlooked.

6.3 Municipal Policy

Each of the urban municipalities and rural municipal districts in the Calgary Region is affected differently by sour gas development. Within the overall framework of the Regional Plan, policies respecting sour gas reserves and facilities should be incorporated into local planning documents. The advantage would be that the local authority could develop policies that are tailored to the specific needs of the community and more precisely reflect the nature and extent of the resource that is at hand.

6.4 Technical Review Panel

Regional and local plan policy and ERCB directives relating to sour gas could be implemented by establishing a technical review panel to address major development proposals, annexation submissions and integration of resource and development plans. This technical review panel would forward its recommendations to the appropriate decision-making authority.

The practice was one of many recommendations made by the ERCB as a result of the West Edmonton inquiry and Saddle Ridge public meeting. In these instances, a liaison committee was suggested to be made up of representatives of the ERCB, the City, the operators and developers. The purpose of this committee was to review development applications, to devise setbacks and appropriate land uses, as well as to ensure proper notification to prospective residents, and deal with ongoing complaints and problems.

A technical review panel may be appropriate to review the land use issues within the primary zone. Such a panel may comprise two or three members of the ERCB staff from appropriate departments, the CRPC, including possibly a staff member and representatives from local municipalities, and representatives from the oil and gas industry. The panel would meet as required and would be co-ordinated from the Region. This panel would combine the industry's technical expertise and the land use principles and policies of the Regional Planning Commission.

This panel could also comment on sour gas development proposals, major land use proposals, and annexation applications concerning the secondary and tertiary zones of the Region where sour gas may be an issue.

6.5 Information Retrieval/Referral System

The first step in the subdivision and development approval process is for the owner or developer to discuss the proposal with local or regional planning staff. In order to best advise the applicant, it is necessary for the CRPC and local municipalities to have at least a general knowledge of the potential conflict that sour gas reserves and facilities may present within their boundaries. The following information could be provided to planners and municipal officials:

- i) maps of the potential sour gas conflict zones;
- ii) maps of the sour gas facilities in each pool/field, such as contained in Appendix 3, together with the separation distances for each level of facility rated pipeline;
- iii) a list of references or sources for more detailed information if it is required;
- iv) a list of operators of sour gas facilities active in the Region or District, together with the name and telephone number of a contact person within the oil and gas company; and
- v) the names of contact persons in the ERCB who may be contacted to discuss special concerns relating to environmental or physical problems or issues.

At the discretion of the local or regional authority, some or all of this information can be passed onto the applicant or used by themselves.

Information available at the outset of the development approval process concerning locations of sour gas reserves and facilities, as well as names of industry contact persons, would help to reduce the number of potential land use conflicts with the sour gas industry.

Current information is vital. For this study, every attempt has been made to locate up-to-date information. However, both land use planning and the sour gas industry are dynamic in nature. Changes occur often and in a random time frame. This is typical of both activities. In attempting to co-ordinate both interests, which is necessary when dealing with land use impacts of sour gas, the need to keep abreast of changes in both areas becomes critical.

i) Sour Gas

It is proposed that a monitoring system be implemented for the sour gas industry which will track well drilling licences, pipeline and plant applications and decisions, and the implementation of those decisions.

Information on drilling activity, pipeline approval and plant construction is already collected by the ERCB for the Province. In order to monitor industry change in the Calgary Region, this data can be extracted, and made available to the Calgary Region for regular review of current activity.

ii) Land Use

In turn, some similar form of data collection will be needed to show:

- land use changes;
- new subdivision applications;
- annexation or changes to urban areas; and
- specific development and building permit applications and approvals.

This information could be provided by the various local levels. It is suggested that the simplest format would include the legal description (1/4 sec-twp-range), the nature and extent (acres/-ha) of the change and its status (proposed or approved). It is proposed that this information be co-ordinated by the CRPC and forwarded to the ERCB.

6.6 Co-existence Measures

A theme common to the previously discussed management options is that they are preventive means to avoid potential conflicts between surface and subsurface use. Their implementation would require active participation by planning authorities, particularly at the Regional level.

They do not, however, address situations where surface development has occurred over sour gas pools.

The Okotoks area exemplifies this situation. Early drilling in the 1950's did not fully define the extent of the sour gas pools. A limited market for gas did not warrant further development at that time. Over time, this rural area has become more urbanized and subdivided into country residential lots, hobby farms and small holdings. As the industry learned of prospects of improved gas and sulphur markets, drilling resumed. The discovery of additional sour gas volumes has caused the extension of the sour gas fields boundaries, and more than doubled the producing life of the area.¹

The issue, therefore, becomes one of co-existence of surface development and sour gas extraction. This issue was also the focus of the West Edmonton Area ERCB inquiry in July 1983, and a public meeting in January and March 1983 concerning the Saddle Ridge Area in northeast Calgary. These areas of producing sour gas reserves are currently experiencing pressures for urban development.

The Board, in its jurisdiction, can prescribe certain measures to be considered by operators relating to wells, batteries, pipelines and gas processing plants that can help ensure safe co-existence with existing or future urban development. For example, the Board may issue a directive to speed up extraction so as to reduce the producing life of a pool.

The application of such measures by industry would be one way to address co-existence. These measures would likely be deliberated at an inquiry or public meeting overseen by the ERCB.

Directives from the Board requesting industry to adopt certain practices are also complemented by other measures, as evidenced in the recommendations arising from the West Edmonton inquiry and Saddle Ridge public meeting. These measures would involve actions by planning authorities such as establishing guidelines for phasing of development, supplying information packages to prospective residents, ensuring that proper inspections of construction are carried out near sour gas facilities, particularly pipelines, and participating actively on committees charged with establishing emergency evacuation plans, setback distances and use of facility rights-of-way.

6.7 Summary

The potential conflict zones and recommended management options will be subject to discussion and scrutiny by the decision makers at the Calgary Regional Planning Commission, the ERCB and members of the gas industry.

¹ Makale & Kylo, A Study of Land Use and Sour Gas, Okotoks-High River, 1983.

Zones of potential conflict were established for planning purposes. These zones identify where and to what extent the sour gas industry could potentially impact surface development in the Calgary Region. In suggesting management strategies for each zone, the authors have based their recommendations on the information collected for this study. It is noted that while zoning provides initial flagging of potential problem areas, it would be necessary to address each situation individually. It is noted also, that while many of the management strategies are applicable to all zones, it is suggested that some may be more important to particular zones.

The primary zone reflects the proven sour gas reserves in the Region. Each field may be subject to a range of management options and measures depending on certain factors, such as the concentration of H_2S of the pool, its proximity to existing or potential urban development, the level of facility development and the surface land ownership, that is, crown, reserve or private. To mitigate potential conflicts with the sour gas industry, to ensure safety of human settlement and to achieve economic and orderly development and use of the land, each of the proposed management options could be applied. Co-ordination and co-operation among all participants in the sour gas industry is especially required.

It is noted that Morley and Sarcee sour gas reserves would be limited only to those management options that involve the ERCB and Federal agencies. The Indian Reserve lands are exempt from the provisions of the Planning Act, and as such would not be subject to regional or local planning policy or procedures respecting sour gas and land use.

The main thrust of the management options concerning lands in the secondary zone would be to establish planning policy and ensure that information concerning sour gas is collected and updated regularly. Because of the 'probable' element of finding sour gas reserves in the secondary zone, industry could advise the planning authorities of new discoveries or changes to the extent of pool boundaries.

The potential areas of sour gas resources, as defined by the tertiary zone, have been liberally interpreted. Therefore management strategies for this zone should concentrate on monitoring the industry's activity and exchanging information between industry and planning authorities. This would serve to alert decision-makers in land use planning matters to change in the dynamic gas industry.

The applicability of management options either across the board or to individual zones will require additional research and analysis.

7.0 CRPC RECOMMENDATIONS

On October 31, 1984, the Regional Plan Committee reviewed a series of recommendations based on the management options discussed in the previous chapter. Decisions were made on each of the consultant's recommendations and these were forwarded to the February 8, 1985 meeting of the Calgary Regional Planning Commission. The Regional Plan Committee recommendations were endorsed by the Commission at that time. The following is a summary of the consultant recommendations, discussion of each and the resulting Commission position on each.

Consultant's Recommendation #1:

The Planning Act should be amended so that development permit approvals are subject to the separation distances outlined in Schedule 6 of the Subdivision Regulation.

Discussion:

It was determined that this would be an unwieldy administrative task and premature action considering our lack of experience with less formal referral procedures.

Commission Position:

That the Consultant's recommendation #1 not be endorsed.

Consultant's Recommendation #2:

The CRPC should formulate and implement regional policy addressing the potential land use impact of sour gas.

Discussion:

It was determined that existing regulations, as administered by the ERCB, would not be significantly improved by the addition of regional policy. However, there may be merit in extending the informal referral system to other primary Potential Use Conflict Zones in the Region.

Commission Position:

That the Consultant's Recommendation not be endorsed as written, but that the Commission, by policy, recognize the good professional practice of the present informal referral mechanism now operating in the South Okotoks Sour Gas Field, and extend it to include other conflict zones.

Consultant's Recommendation #3:

Policies concerning land uses adjacent to sour gas reserves and facilities should be incorporated into local planning documents.

Discussion:

It was determined that although provisions would not be incorporated in the Calgary Regional Plan requiring sour gas policies in local planning documents, this should nonetheless be undertaken at the discretion of the municipality.

Commission Position:

That the Consultant's Recommendation #3 be endorsed.

Consultant's Recommendation #4:

A technical review panel should be established to address major development proposals, annexation submissions, and integration of resource and land use development plans in the Primary Zone.

Discussion:

A Sour Gas Committee, with responsibilities similar to that of the Road Study Committee, would be preferable to a technical review panel.

Commission Position:

That the Commission not endorse the Consultant's Recommendation #4 as written but that a Sour Gas Committee be established with duties similar to those of the Road Study Committee.

Consultant's Recommendation #5A:

The CRPC should have available, and could provide to municipalities within the Region, information on existing sour gas facilities.

Discussion:

CRPC staff would ensure that the Sour Gas Study and other sources are available to municipalities for use as technical background documents and that the information is regularly updated.

Commission Position:

That the Consultant's recommendation 5A be endorsed.

Consultant's Recommendation #5B:

The CRPC could institute a system of monitoring changes in sour gas and land use development.

Discussion:

Staff could compile periodic updates of information from the ERCB and other sources, and could also provide the ERCB with major land use surveys, as they are completed.

Commission Position:

That the Consultant's Recommendation #5B be changed to read as follows and subsequently endorsed:

"Given the importance of using the most recent information, the CRPC could continue and refine a system of monitoring changes in sour gas and land use development."

Consultant's Recommendation #6:

The CRPC should encourage the ERCB to prescribe measures to help ensure safe co-existence of subsurface and surface developments.

Discussion:

The Commission and staff should continue to support the ERCB's efforts to alleviate conflicts between subsurface and surface developments.

Commission Position:

That the Consultant's Recommendation #6 be endorsed as written.

The Regional Plan Committee made the following additional recommendation which was endorsed as written by the Commission:

"The CRPC should encourage the ERCB to require the rapid depletion of gas from areas where there are serious conflicts between sour gas and land use development."

8.0 IMPLEMENTATION OF CRPC RECOMMENDATIONS

The observations and conclusions drawn throughout the study have emphasized that the key to the successful reduction of potential conflicts between surface and subsurface use is the distribution of information and co-operation among the participants involved. It is hoped that through the implementation of the CRPC recommendations the objectives of this study will be achieved.

8.1 Sour Gas Committee

At the time of printing, the Commission has not yet finalized the details of organizing the Sour Gas Committee. However, it is proposed that the first meeting be set for November, 1985. The Committee is proposed to be organized according to the following structure:

Purpose

The Committee is intended as a link between the CRPC and the ERCB. The Committee should meet regularly, once or twice yearly, with representatives of the ERCB to review new and proposed sour gas development within the Calgary Region, and to communicate land use information to the ERCB. This communication will be a step toward avoiding conflicts between land use and sour gas development.

The Committee could also meet as required to make recommendations to the Commission on major specific sour gas issues referred to the CRPC.

Membership

The size of the Committee should perhaps be determined by the number of municipalities most seriously affected by sour gas development. Some areas, particularly in the eastern portion of the Region, are not affected, and therefore it may not be necessary for those areas to be represented on the Committee. There are ten member municipalities located in or near the Primary Zone, as identified in this study. The Commission may want to consider giving priority to representation of these municipalities:

- City Airdrie
- City of Calgary
- Summer Village of Chestermere Lake
- Town of Crossfield
- Town of High River
- Town of Okotoks
- Town of Turner Valley
- M.D. of Foothills
- M.D. of Rocky View
- Improvement District No. 8

In addition, the Committee should include all members of the Commission's Executive.

Quorum

Quorum for the Committee should be established as fifty percent of the Committee membership, plus one.

8.2 Municipal Information Program

The Sour Gas Study identified the need for increased awareness of the potential conflict between land use development and sour gas facilities. This is true not only at the regional level, but also at the local level. The work that the CRPC has done in this area, and the contact established with the ERCB and industry representatives indicate that we could play a role in providing more information to local municipalities. A program of providing municipalities with information on natural resource development should therefore be developed.

Purpose

Such a program would serve the following purposes:

- It would help to implement recommendations included in the Sour Gas Study.
- It would get information to the level where it will be used to avoid conflicts between land use and natural resource development.
- Such a program would help to establish the CRPC as a source of information on sour gas issues.
- The program would also help to gain support for and interest in the Sour Gas Study and the CRPC recommendations.

Program Elements

The principle target for the program should be the local development officers, who will deal most closely with land use and resource development. Some councils and municipal planning commissions, especially those most affected, may also be interested in receiving information firsthand. The program should therefore include the following elements:

i) Presentations to Municipal Councils

Accompanying the release and distribution of this final report, council will be advised of the availability of this service and presentations would be scheduled upon request. The presentation would include highlighting potential conflict areas, a review of regulations and guidelines, update of ERCB and industry initiatives and activity and a review of the CRPC recommendations and suggestions for implementation of these at the local level; focusing on the role of the municipality in sour gas development. The presentation would reach decision-makers directly and increase effective involvement at the local level.

ii) Workshop for Development Officers

It is proposed that the CRPC host a workshop for development officers. The workshop would likely be held after any Council meetings, as the meetings may serve to prepare the development officers for the workshop and provide a starting point in terms of information. The objectives of the workshop would be similar to those of the Council meetings but would focus on more specific issues and concerns. Members of the ERCB as well as industry would be invited to attend in order to ensure input from all possible sources.

8.3 Development Guidelines Handbook

The CRPC recommendation #3 indicates that policies for land uses adjacent to sour gas reserves and facilities should be incorporated into local planning documents. Should municipalities wish to respond to this recommendation, a handbook would be a method of providing general assistance through specific development guidelines.

Purpose

The proposed guidelines would be advisory, and could be contained in an easy reference handbook available to all municipalities and interested parties. The technical information and inventory contained in this report would be used, in addition to the handbook, for background information. The information could then be used by the municipality in assessing development proposals, and reviewing their land use planning documents. There would be no requirement to adopt the guidelines, but the Commission would encourage municipalities to consider them.

It should also be made clear that these guidelines would not be intended to impose restrictions on industry, as this would be outside the municipality's jurisdiction. Instead, the emphasis would be on development adjacent to existing sour gas facilities and reserves.

In addition, the guidelines will not address health and safety issues.

Content

The handbook could be a valuable way of combining information from the Sour Gas Study, the Regional Plan, and other sources into one document for use as a reference. Some of the items it might address include:

- the role of the municipality;
- the principle of protection areas of known sour gas extraction;
- details on subdivision and development setbacks;
- criteria for assessing potential use conflict;
- the potential use conflict zones identified by the Sour Gas Study;

- examples of situations where sour gas facilities should be taken into account;
- land use criteria for assessing an application for a sour gas processing plant;
- contacts within the industry and the ERCB for additional information.

9.0 AREAS FOR FURTHER STUDY

In researching sour gas, gaps in the information base were found which required interpretation of some factors. Since this study was the first of its kind undertaken by the Calgary Regional Planning Commission, further research by the various participants into the following identified areas is required to support or amend some of the assumptions used:

- i) More research is required on the release of pollutants, specifically, sulphur dioxide emissions, by sour gas processing facilities, and the effects these may have on human and animal health and the environment. Harmful effects of concentrations of sulphur dioxide emissions have been documented, but no conclusions or firm recommendations have been made that are accepted by both industry and the public.
- ii) Further investigations are required into the actual extent of the sour gas resource, particularly within the secondary and tertiary zones as identified in this study. This could be done by detailed subsurface geological analysis utilizing all available data, including any dry holes in the area.
- iii) Further analysis pertaining to the nature of the proven sour gas reserves in the Region is necessary. More detailed information on each of the producing sour gas fields would assist in evaluating their actual impact on existing and proposed surface development. This information could address items such as producing life and could specify hazard potential.
- iv) To complement the preceding item, further documentation on the nature of the existing land use, and identification of future development plans of areas underlain by proven sour gas reserves is also required.
- v) Further research and analysis regarding the application of management options either across the board or for individual zones is necessary.

APPENDIX 1

ERCB INTERIM DIRECTIVE

ID 81-3

ENERGY RESOURCES CONSERVATION BOARD
Calgary Alberta

Interim Directive
ID 81-3

TO: ALL WELL, PIPELINE AND GAS PLANT OPERATORS

MINIMUM DISTANCE REQUIREMENTS SEPARATING
NEW SOUR GAS FACILITIES FROM RESIDENTIAL
AND OTHER DEVELOPMENTS

This directive replaces Interim Directive ID 79-2 issued 22 February 1979. Appendices 1 and 2 are identical to those in ID 79-2 with the exception that the "Applications" section of Appendix 1 has been deleted. A new Appendix 3 sets out requirements for applications for well licences and pipeline permits and includes a section dealing with concurrent applications for these facilities.

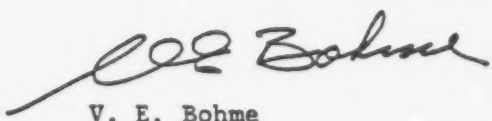
The separation distances described in this directive were developed by Alberta Environment and the Board and have been applied since early 1979 in granting approvals for sour gas facilities near areas of public use. These distances increase as the potential sour gas release volumes increase and with increasing population density.

With regard to encroachment of occupied buildings on existing sour gas facilities, the Subdivision Regulations of The Planning Act, 1977, were amended by Order in Council 283/79 to require setbacks similar to the Board's separation distances.

Interim Directive ID 79-2 is hereby rescinded.

ISSUED at Calgary, Alberta, on 16 December 1981.

ENERGY RESOURCES CONSERVATION BOARD



V. E. Bohme
Board Member

APPENDIX 1
TO ID 81-3MINIMUM DISTANCE REQUIREMENTS SEPARATING
NEW SOUR GAS FACILITIES FROM RESIDENTIAL
AND OTHER DEVELOPMENTS

Definitions:

For the purpose of this Directive:

- (1) sour gas is natural gas having an H_2S content of 10 moles per kilomole or greater, or such lesser or greater H_2S content that the Board may stipulate in a particular case;
- (2) a sour gas facility is any facility which produces, processes, or transports sour gas including:
 - a) gas wells producing or capable of producing sour gas,
 - b) gas lines or secondary lines that transport sour gas,
 - c) gas plants, and
 - d) any other installations that the Board may designate;
- (3) unrestricted country development is defined as any collection of permanent dwellings situated out of urban centres and having more than eight permanent dwellings per quarter section; and for the purpose of this Directive includes any similar development the Board may designate as an unrestricted country development;
- (4) a public facility is defined as a recreational area such as a campground, or a public building such as a rural school or hospital, situated out of urban centres; and for the purpose of this Directive includes any similar development the Board may designate as a public facility;
- (5) an urban centre is defined as a city, town, village, or other incorporated centre, and for the purpose of this Directive includes any similar development the Board may designate as an urban centre;
- (6) separation distance is the required distance between a sour gas facility and developments such as individual permanent dwellings, unrestricted country development, public facilities, and urban centres;
- (7) the calculated flow rate of potential H_2S release from a sour gas well shall be established using the maximum wellhead deliverability that can be attained at any time through the tubing against zero wellhead pressure, and shall be expressed in the unit m^3/s at standard conditions;

- (8) the calculated volume of potential H₂S release from a sour gas facility, other than a sour gas well, shall be established using the maximum operating pressure, shall be expressed in the unit m³ at standard conditions, and for the purposes of this calculation shall assume that any automatic block valves close instantaneously upon failure of the facility.

Policy:

For the purpose of the policy, sour gas facilities shall be grouped into levels in accordance with their capability to release sour gas.

- (1) A level 1 facility is a sour gas well with a potential H₂S release rate of 0.3 m³/s or less, or any other sour gas facility with a potential to release 300 m³ of H₂S or less. A new Level 1 facility, other than a sour gas well shall have no separation distance requirement other than that associated with the easement for the right of way. All wells remain subject to Section 2.110 of the Oil and Gas Conservation Regulations which requires a separation distance of 0.1 km. Notwithstanding this clause, the Board may specify some other separation distance for a Level 1 facility should the circumstances warrant such action.
- (2) A Level 2 facility is a sour gas well with a potential H₂S release rate of more than 0.3 m³/s and less than 2.0 m³/s, or any other sour gas facility with a potential to release more than 300 m³ and less than 2000 m³ of H₂S. A new Level 2 facility shall be situated to provide 0.1 km separation distance between it and any permanent dwelling, and 0.5 km separation distance between it and any urban centre or public facility.
- (3) A Level 3 facility is a sour gas well with a potential H₂S release rate of more than 2.0 m³/s and less than 6.0 m³/s, or any other sour gas facility with a potential to release more than 2000 m³ and less than 6000 m³ of H₂S. A new Level 3 facility shall be situated to provide 0.1 km separation distance between it and any permanent dwelling, 0.5 km separation distance between it and any unrestricted country development, and 1.5 km separation distance between it and any urban centre or public facility.
- (4) A Level 4 facility is a sour gas well with a potential H₂S release rate of more than 6.0 m³/s, or any other sour gas facility with a potential to release more than 6000 m³ of H₂S. A new Level 4 facility shall be so situated that as a minimum, it shall meet the requirements set out for a Level 3 facility. However, the Board may require greater separation distances or set out other such requirements it deems necessary.
- (5) For ease of reference a summary of the foregoing policy is presented in Appendix 2.

- (6) The Board recognizes that notwithstanding the level into which an application for a sour gas facility may fall, under some special circumstances a detailed review may indicate that another H₂S release level is more applicable.

APPENDIX 2
TO ID 81-3

SUMMARY OF MINIMUM DISTANCE REQUIREMENTS SEPARATING
NEW SOUR GAS FACILITIES FROM RESIDENTIAL AND
OTHER DEVELOPMENTS

Level of Sour Gas Facility	Potential H ₂ S Releases		Minimum Distance to Various Developments
	Sour Gas Well Release Rate m ³ /s	Other Sour Gas Facility Release Volume m ³	
1	<0.3	<300	- Minimum distance for wells 0.1 km as stated in Section 2.110 of the Oil and Gas Conservation Regulations. - No minimum distance for other sour gas facilities except that associated with easement for right of way, unless otherwise specified by the Board.
2	0.3 - 2.0	300 - 2000	- 0.1 km to individual permanent dwellings and unrestricted country development. - 0.5 km to urban centre or public facility.
3	2.0 - 6.0	2000 - 6000	- 0.1 km to individual permanent dwellings up to 8 dwellings per quarter section. - 0.5 km to an unrestricted country development. - 1.5 km to an urban centre or public facility.
4	>6.0	>5000	- As specified by the Board, but not less than Level 3.

APPENDIX 2
SUBDIVISION AND TRANSFER REGULATION
OF
THE PLANNING ACT, SCHEDULE 6



GOVERNMENT OF THE PROVINCE OF ALBERTA

THE PLANNING ACT, 1977

SUBDIVISION REGULATION

being Alberta Regulation 132/78 with amendments
up to and including Alberta Regulation 138/79

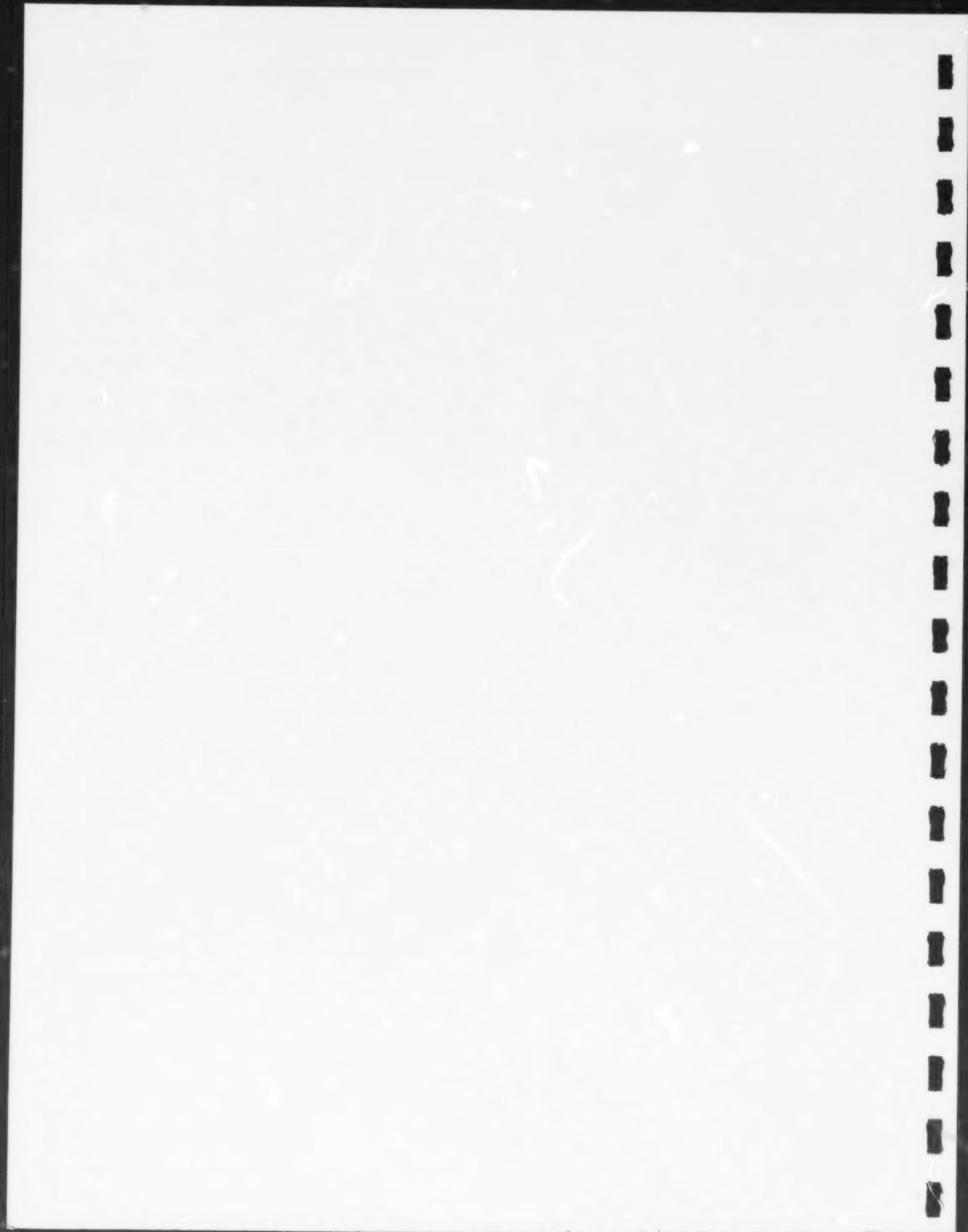
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SCHEDULE 6

MINIMUM SEPARATION DISTANCES FROM SOUR GAS FACILITIES

1 In this Schedule,

(a) "Board" means the Energy Resources Conservation Board;

(b) "existing or probable development" has the meaning given to it by section 11.1(4);

(c) "potential release rate", with reference to a sour gas facility consisting of a well, means the estimated rate of flow of hydrogen sulphide from the well, expressed in cubic metres of hydrogen sulphide per second at standard conditions, assuming a failure of or damage to the well that in turn resulted in zero wellhead pressure;

(d) "potential volume release", with reference to a sour gas facility other than a well, means the estimated volumes of hydrogen sulphide, expressed in cubic metres at standard conditions, that would be released to the atmosphere in event of a failure of the facility or damage to the facility assuming that

(i) the facility is being operated at its maximum operating pressure at the time of the failure or damage, and

(ii) any automatic block valves in the facility close instantaneously upon the failure or the damage,

(e) "rural public facility" means

(i) an area of land or a building used for recreational purposes, or

(ii) a school, hospital or other public building and the land used in connection with it,

if it is located outside an urban municipality;

(f) "standard conditions" means the standard pressure and temperature conditions prescribed by the regulations under The Oil and Gas Conservation Act for the metering and measurement of gas;

(g) "unrestricted country development" means any area outside an urban municipality containing permanent dwellings and having a density of more than 8 dwellings per quarter section;

(h) "urban municipality" means

(i) a city, town, new town, village or summer village, or

(ii) a hamlet (as defined in The Municipal Government Act) having a population of at least 75 persons.

2 For the purposes of this Schedule, sour gas facilities are classified as follows:

(a) a "Level 1 facility" is

- (i) a well having potential release rate of 0.3 cubic metres of hydrogen sulphide per second or less, or
- (ii) a sour gas facility, other than a well, having a potential volume release of 300 cubic metres of hydrogen sulphide or less;

(b) a "Level 2 facility" is

- (i) a well having a potential release rate of more than 0.3, but not more than 2, cubic metres of hydrogen sulphide per second, or
- (ii) a sour gas facility, other than a well, having a potential volume release of more than 300, but not more than 2000, cubic metres of hydrogen sulphide;

(c) a "Level 3 facility" is

- (i) a well having a potential release rate of more than 2, but not more than 6, cubic metres of hydrogen sulphide per second, or
- (ii) a sour gas facility, other than a well, having a potential volume release of more than 2000, but not more than 6000, cubic metres of hydrogen sulphide;

(d) a "Level 4 facility" is

- (i) a well having a potential release rate of more than 6 cubic metres of hydrogen sulphide per second, or
- (ii) a sour gas facility, other than a well, having a potential volume release of more than 6000 cubic metres of hydrogen sulphide.

3 The following are the minimum separation distances between the location of any existing or probable development and a sour gas facility classified in accordance with section 2 of this Schedule:

(a) in the case of a Level 1 facility consisting of a well, the minimum separation distance is 0.1 kilometres;

(b) in the case of a Level 1 facility consisting of a pipeline, the minimum separation distance is the distance between the pipeline and the boundary of the right-of-way for the pipeline;

(c) in the case of a Level 1 facility that is not a well or a pipeline, the minimum separation distance is the distance between the facility and the boundary of the site for the facility;

(d) in the case of a Level 2 facility, the minimum separation distance is

- (i) 0.1 kilometres, if the existing or probable development is a permanent dwelling, or

(ii) 0.5 kilometres, if the existing or probable development is within an urban municipality or is a rural public facility;

(e) in the case of a Level 3 facility or Level 4 facility, the minimum separation distance is

(i) 0.1 kilometress, if the existing or probable development is a permanent dwelling,

(ii) 0.5 kilometres, if the existing or probable development is within an unrestricted country development, or

(iii) 1.5 kilometres, if the existing or probable development is within an urban municipality or is a rural public facility.

4 Section 3 of this Schedule does not apply to a case where the proposed subdivision is being made for the purpose of providing a site for a sour gas facility.

AR138/79

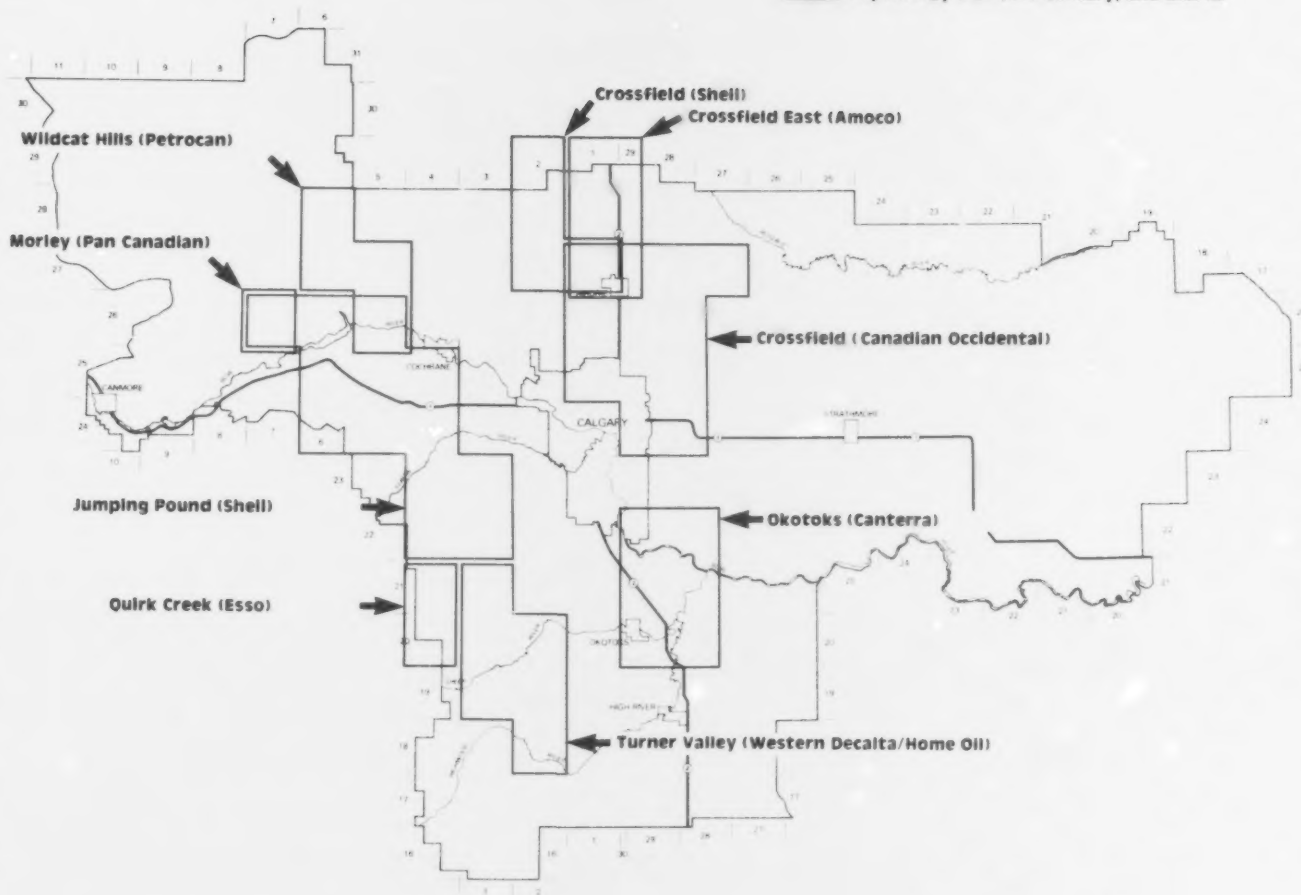
APPENDIX 3

PIPELINE SYSTEMS FOR SOUR GAS
POOLS IN THE CALGARY REGION*

- * The following pool maps illustrate, as accurately as possible, the individual operating sour gas facility systems in the Region. The information on location of facility and pipeline facility level ratings, as shown on the maps, was from ERCB. Facility locations were verified by individual gathering system operators. NOTE: Facility levels are shown only for pipelines. Setbacks as shown are the greatest or maximum separation distances required under Schedule 6 of Subdivision Regulations.



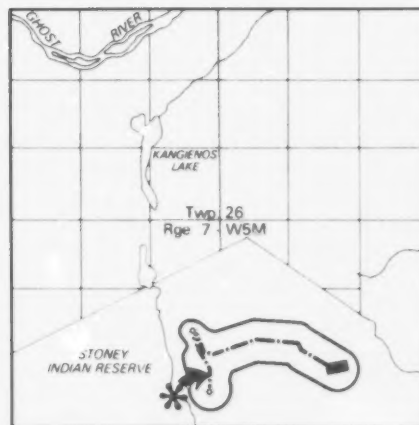
Sour Gas Study of the Calgary Region
Prepared by C.E.P., J.R. Century, and C.R.P.C.



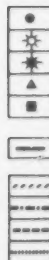
Index to Pipeline System Maps

 Sour Gas Study of the Calgary Region
Prepared by C.E.P., J.R. Century, and C.R.P.C.





Oil Well
Gas Well
Oil & Gas Well
Battery
Satellite
Maximum Separation
Distance¹
Pipeline Levels:
1
2
3
4



*Discrepancy may exist between the industry operators and the ERCB regarding level ratings of this segment of the pipeline

0 2 4 6
Kilometres



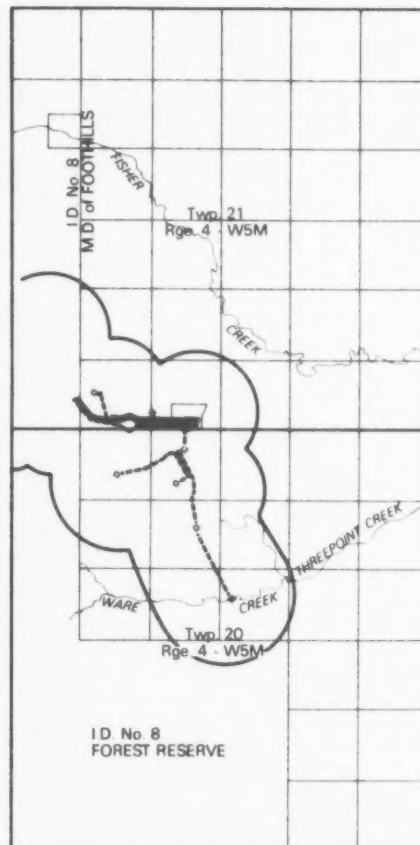
Morley (Pan Canadian)

Due to the scale of the map, the location of facilities and setbacks are approximate. Special note should be made for separation distances shown for Level 1 pipelines; these are intended to generally reflect the required separation distance being to the pipeline right of way.



Sour Gas Study of the Calgary Region
Prepared by C.E.P., J.R. Century, and C.R.P.C.





Oil Well
Gas Well
Oil & Gas Well
Battery
Satellite
Maximum Separation
Distance
Pipeline Levels:

1
2
3
4

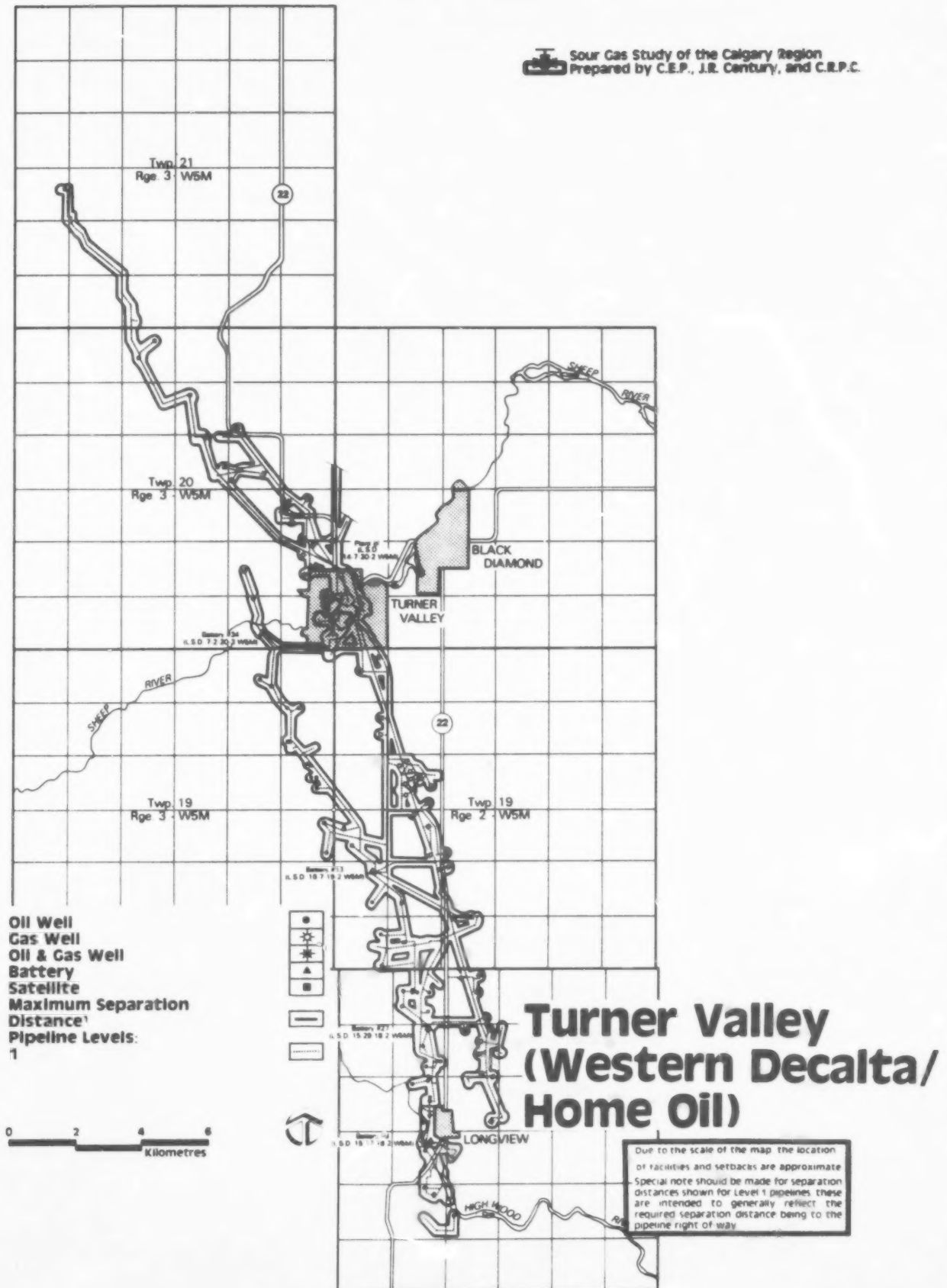


0 2 4 6
Kilometres

Quirk Creek (Esso)

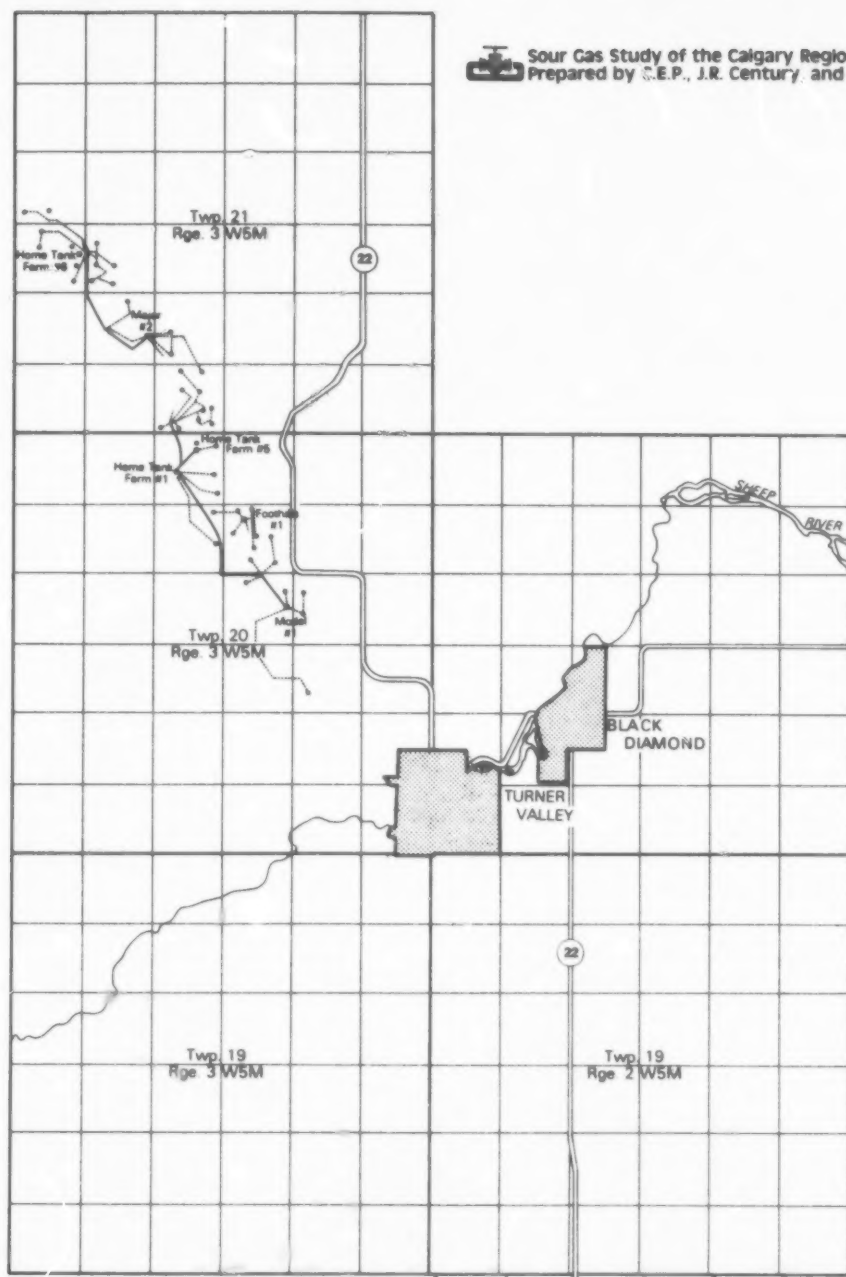
Due to the scale of the map, the location of facilities and setbacks are approximate. Special note should be made for separation distances shown for Level 1 pipelines; these are intended to generally reflect the required separation distance being to the pipeline right of way.

 Sour Gas Study of the Calgary Region
Prepared by C.E.P., J.R. Century, and C.R.P.C.





Sour Gas Study of the Calgary Region
Prepared by C.E.P., J.R. Century, and C.R.P.C.

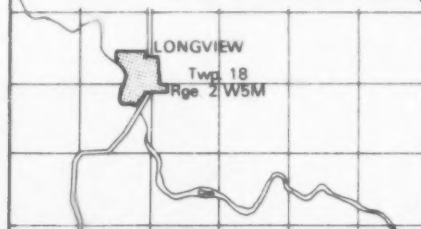


Oil Gathering Lines
Oil Well
Battery
Well Flow Lines

0 2 4 6
Kilometres

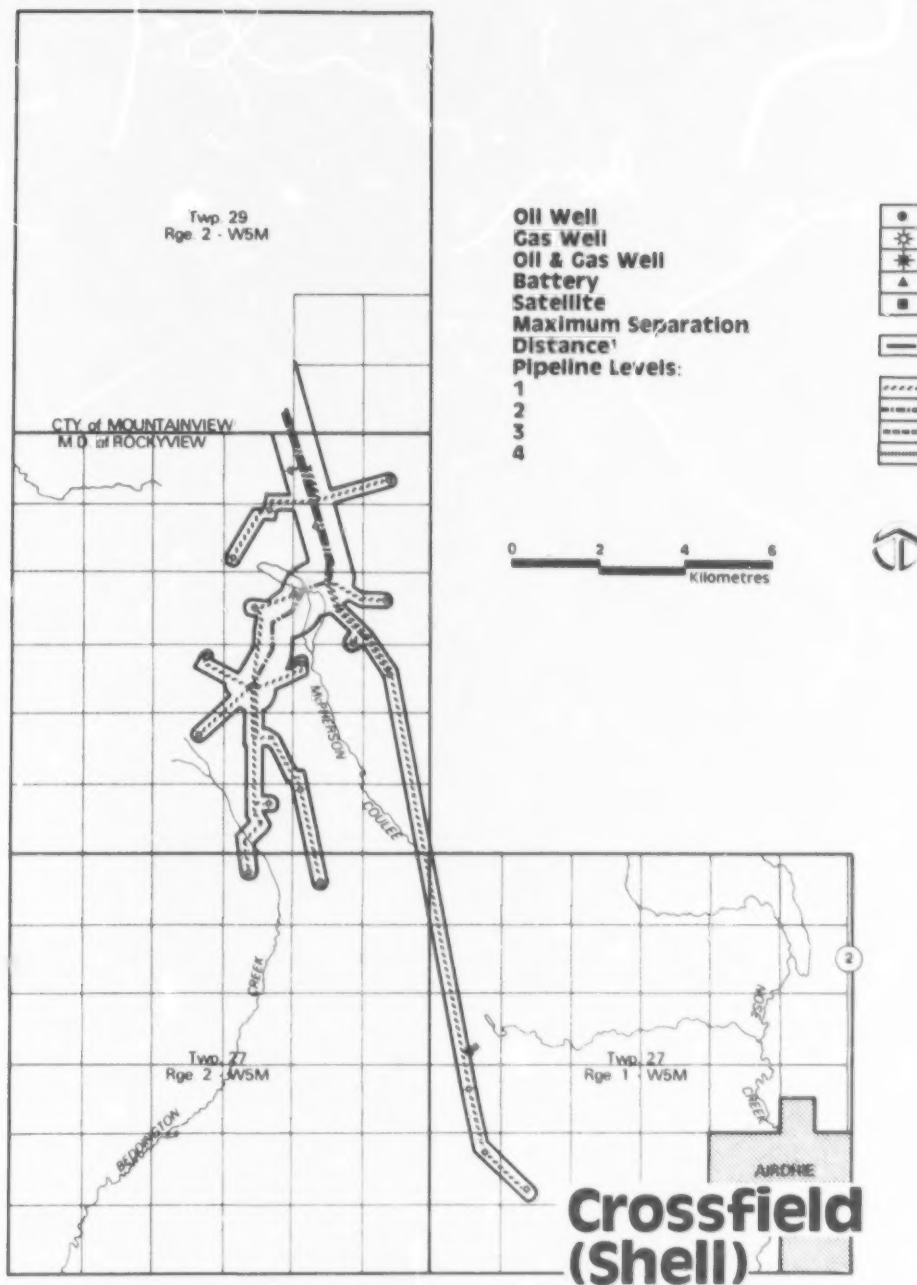


Turner Valley/Home Oil (Oil Gathering System)*



* The oil gathering system for Home Oil's north Turner Valley system is shown because the average concentration of H₂S associated with the oil production is quite high (6%). Level ratings of the pipelines were not available.

 Sour Gas Study of the Calgary Region
Prepared by C.E.P., J.R. Century, and C.R.P.C.



Due to the scale of the map, the location of facilities and setbacks are approximate. Special note should be made for separation distances shown for level 1 pipelines; these are intended to generally reflect the required separation distance being to the pipeline right of way.

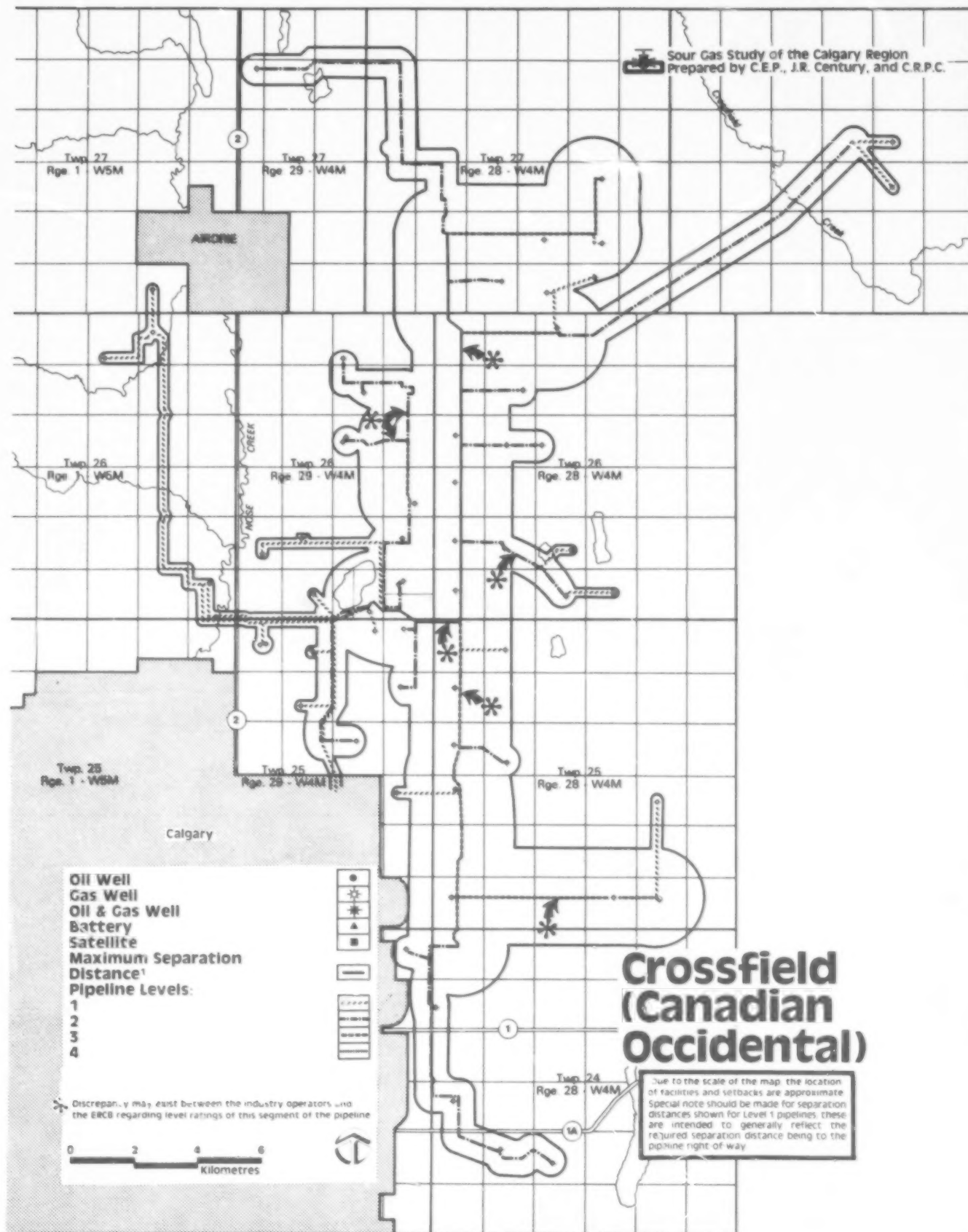


*Discrepancy may exist between the industry operators and the ERCB regarding level ratings of this segment of the pipeline

0 2 4 6
Kilometres

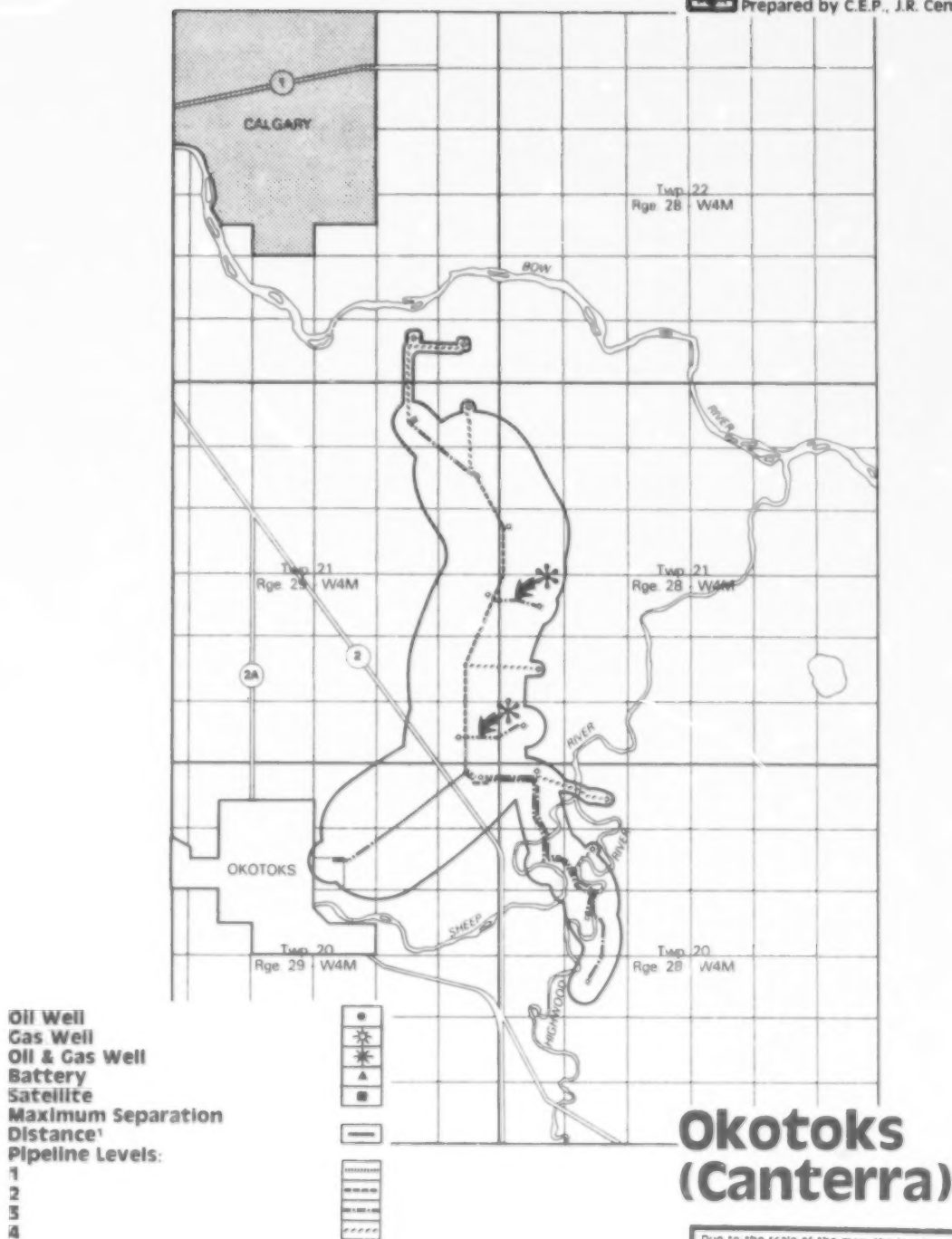


Due to the scale of the map, the location of facilities and setbacks are approximate. Special note should be made for separation distances shown for Level 1 pipelines, these are intended to generally reflect the required separation distance being to the pipeline right-of-way.





Sour Gas Study of the Calgary Region
Prepared by C.E.P., J.R. Century, and C.R.P.C.



*Discrepancy may exist between the industry operators and the ERCB regarding level ratings of this segment of the pipeline

0 2 4 8
Kilometres



APPENDIX 4

CONCLUSIONS OF ERCB REPORT ON
"SOUR GAS PROCESSING IN ALBERTA"

REPORT TO THE LIEUTENANT GOVERNOR IN COUNCIL

SOUR GAS PROCESSING IN ALBERTA

**A REVIEW OF EVIDENCE PRESENTED AT
RECENT ERCB HEARINGS RESPECTING THE
IMPACTS AND SURVEILLANCE OF
SOUR GAS PLANTS**

APRIL 1982



**ENERGY RESOURCES CONSERVATION BOARD
ALBERTA, CANADA**

P R E F A C E

This report was prepared by the Energy Resources Conservation Board to advise the Lieutenant Governor in Council and others of the general concerns raised by interveners at recent hearings respecting the processing of sour gas in Alberta. The report summarizes the concerns expressed at the hearings and provides the Board's assessment of them. Issues related to the specific applications considered by the Board are discussed in the three decision reports: Decision 82-3, Decision 82-12 and ERCB Report 82-E.

1 SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The Board recently concluded hearings to consider applications to amend the approvals for the Jumping Pound and Quirk Creek gas plants and for a pipeline permit to connect the Moose and Whiskey sour gas reserves to the latter plant. After reviewing the concerns and evidence presented at those hearings by the interveners, the Board concluded that much of it was not directly related to the specific applications, but instead related to broad environmental issues respecting sour gas operations in general. Since many of the issues are beyond the Board's jurisdiction it decided to report on them to the Lieutenant Governor in Council. The following summarizes the evidence and provides the Board's assessment, conclusions and recommendations with respect to it.

1.1 THE ACIDIFICATION OF SOILS

The interveners contended that SO₂ emissions from sour gas plants either have or will cause increased soil acidity thereby damaging the soil and reducing its productivity. They argued that the solution is to eliminate the emissions as far as possible by installing facilities to recover essentially 100 per cent of the sulphur in the gas.

The Board finds that there is a divergence of scientific opinion as to the extent of the deposition of SO₂ emissions on Alberta soils ranging from modest to possibly significant. It agrees that the issue of soil acidification is potentially serious in the long-term and while there is not justification to impose further limitation on plant operations at this time, a comprehensive research program should be undertaken to determine the extent of the deposition.

RECOMMENDATION

The Board recommends that priority be given to the development of a comprehensive research program into the deposition of potential acid-formers in soils in Alberta.

1.2 SOUR GAS PLANT EMISSIONS OF SO₂ AGGRAVATE LIVESTOCK DISEASES

The interveners' position was that SO₂ emissions deposited in soils suppress the uptake of selenium by vegetation which is an essential element for livestock. It was alleged that the incidence of selenium deficiency diseases near sour gas plants is increasing and is a serious problem for agriculture.

The Board found that there was inadequate evidence to demonstrate in any quantitative manner the seriousness or the extent of selenium related diseases in various parts of Alberta. It also has reservations about the causal relationship between SO₂ emissions and selenium related diseases alleged by the interveners. Nevertheless, the Board agrees that the matter is potentially serious and warrants investigation.

RECOMMENDATION

The Board recommends that a careful and thorough evaluation of the alleged relationship between SO₂ emissions and selenium related diseases be undertaken by a competent research team.

1.3 THE IMPACT OF SO₂ EMISSIONS ON STREAMS AND LAKES

The potential impact of SO₂ emissions on streams and lakes was generally referred to by the interveners but particular emphasis was placed on emissions from oil sands plants.

The Board sees no evidence to indicate damage to date but believes that it would be desirable to undertake appropriate monitoring studies.

RECOMMENDATION

The Board recommends that Alberta Environment make arrangements with the Province of Saskatchewan to conduct environmental baseline investigation on lakes and streams in regions downwind of the Athabasca Oil Sands in Alberta and Saskatchewan.

1.4 THE EMISSION OF TRACE METALS AND OTHER CHEMICALS FROM SOUR GAS PLANTS

It was suggested by the interveners that heavy metals, dioxins, hydrogen cyanide and carcinogenic substances could be emitted to the atmosphere at sour gas processing plants. They contended that sophisticated monitoring should be undertaken to ensure public safety.

The Board can find no evidence to support the claims respecting dioxins, hydrogen cyanide and carcinogenic substances. With respect to heavy metals, the Board does not believe that this is a problem at Alberta plants but in order to be absolutely safe agrees that the emissions from a representative group plants should be analyzed.

CONCLUSION

The Board, with the assistance of Alberta Environment, intends to proceed with the commissioning of a series of special tests on the emissions from 5 to 10 gas plant stacks to investigate whether heavy metals and possibly other trace compounds are present.

1.5 SULPHUR RECOVERY AT SOUR GAS PLANTS

The interveners contended that under current legislation it is the Board's duty to require all sour gas plants to install the "best available technology" regardless of cost so that emission of SO_2 would be essentially eliminated.

The Board does not agree with the interveners and believes that the legislation directs it to control or limit pollution and that the degree of limitation would be influenced by various considerations including economics.

The Board also found that Alberta's ambient air quality standards are as strict as any in Canada. Furthermore, the emission control standards applied to the oil and gas industry are more restrictive than those applying to any other extraction industry.

The actual recovery of sulphur at processing plants in Alberta is in excess of 97 per cent and the total cost of requiring all plants to install tail gas clean-up facilities in order to recover an additional 1.0 to 1.5 per cent would be enormous. The Board estimates that the cost per tonne of sulphur recovered would be in the order of \$2000 as compared to a current sales price of less than \$100.

CONCLUSION

The Board concludes that its current guidelines respecting sulphur recovery levels at sour gas plants are satisfactory and should not be amended. The Board and Alberta Environment will continue their practice of periodically reviewing the guidelines having regard for developments in technology and evidence of environmental impacts.

1.6 RECOMMENDATION 21 OF THE ACID RAIN SUBCOMMITTEE

The interveners recommended that the Board urge the Alberta Government to implement Recommendation 21 which reads as follows:

"That the Government of Alberta accord maximum priority to the control of acid-rain causing pollutants from industries in the province. The Subcommittee recommends that the Provincial Government adopt as its guiding policy a goal of zero increase in acid-rain causing emissions over present levels up to the year 2000, and an annual decrease by a prescribed amount each year thereafter."

The Board is concerned that none of the proponents of the recommendation have examined its implications. The Board's own assessment leads it to conclude that the proposal is impractical and unrealistic; would be tremendously expensive and is not supported by any cost/benefit analysis or impact study; appears to be discriminatory against Alberta; is contrary to the Federal Government's self-sufficiency objectives and has an unreasonable base period.

RECOMMENDATION

Recommendation 21 of the Acid Rain Subcommittee is not appropriate and should not be adopted or implemented.

1.7 INJECTION OF WASTE GASES FROM SOUR GAS PLANTS

It was argued that by injecting the waste gases from sour gas plants pollution could be essentially eliminated and indeed the gases could be used for enhanced oil recovery.

The Board found no evidence to support injection. As a means of avoiding pollution, the evidence is clear that essentially 100 per cent recovery of the sulphur is less costly and has fewer environmental and safety problems. As a means of increasing oil recovery the suggestion is technically possible under certain circumstances but there is no evidence to suggest it is economically feasible.

CONCLUSION

The Board will not require all future applicants for approval of sour gas plants to assess the viability of waste gas injection.

1.8 THE ADEQUACY OF CURRENT MONITORING REQUIREMENTS AT SOUR GAS PLANTS

It was suggested that current monitoring requirements are not adequate and need strengthening. Particular reference was made to the need for independent agencies to conduct the monitoring.

The Board in Appendix A summarizes the current monitoring requirements imposed by Alberta Environment and the Board. The Board does not believe it would be practical to require that the monitoring program be undertaken by independent agencies.

CONCLUSION

The Board believes that the current monitoring program is generally complete but should be supplemented by the chemical analyses of gas plant stack emissions and additional soil monitoring referred to previously.

1.9 THE ACCURACY OF PLANT EMISSION RECORDS AND THE DEGREE
TO WHICH PLANT OPERATIONS ARE CHECKED FOR COMPLIANCE WITH
REQUIREMENTS

The interveners suggested that at least some of the plant emission records are not sufficiently accurate and that measurements should be improved. They also implied that the surveillance of sour gas operations is inadequate. Appendix B summarizes the current surveillance program.

CONCLUSION

After reviewing the evidence the Board is generally satisfied with the accuracy of the records but intends to make an in-depth review.

APPENDIX 5

A SUMMARY OF REGIONAL NATURAL
RESOURCE POLICIES IN ALBERTA

REGIONAL NATURAL RESOURCE POLICIES

1. Red Deer Region

This non-renewable resources policy concentrates on coal, gravel and phosphate, with only limited application to the oil and gas industry. The policy aims to:

- (a) encourage the liaison of regulatory agencies and industry;
- (b) improve identification of potential resources areas; and
- (c) prepare an inventory of abandoned sites requiring reclamation.

2. Oldman River Region

The transportation policy refers to pipelines and transmission lines, as a minor constituent of the regional/provincial transportation system. The policy aims to:

- (a) avoid land fragmentation;
- (b) avoid viable agricultural lands;
- (c) encourage urban municipalities to keep records of existing facilities (e.g. pipelines) to reduce hazards or conflict;
- (d) recommends that compensation for disruption of use be continued for as long as the disruption lasts.

3. Southeast Region

The mineral extraction policy recognizes the regional significance of the energy and mineral resource extraction industry. The policy aims to:

- (a) promote co-ordination of regulations with the industry and the ERCB;
- (b) develop a comprehensive inventory of resources within the region; and
- (c) encourage municipalities to protect all areas with a high potential for resource extraction from conflicting development.

4. South Peace Region (Grande Prairie)

The non-renewable resources of this region include oil, oil sands, gas, coal, iron ore, and silica. The policy recognizes the dependence of continued and accelerated growth on the oil and gas industry. Wells and batteries are exempt from the provisions of the Planning Act and Subdivision Regulation. The policy aims to:

- (a) establish oil and gas extraction practices which minimize agricultural land use impact;

- (b) *locate pipelines away from settlement;*
- (c) develop multi-use pipeline corridors; and
- (d) assist the ERCB in hearings on land use issues.

5. Peace River Region

The resources of the Region include oil and gas, sand, gravel and peat moss. The policy is the same as that for the South Peace Region.

6. Edmonton Metropolitan Region

The extractive resource conservation policy recognizes the significance of the resources as an economic asset and not an environmental liability. The policy aims to:

- (a) delineate special control areas in the vicinity of oil and gas fields;
- (b) develop a similar designation in municipal bylaws;
- (c) prohibit change of use in control areas except where subdivision and change of use is not detrimental;
- (d) provide an 800 m buffer between the resource and incompatible uses, except for single family dwellings or agricultural use or when the resource extraction is complete or deemed to be of low significance;
- (e) use the oil and gas well spacing and target regulations of the Oil and Gas Conservation Act as a guideline for subdivision applications.

7. Battle River Region

The resource policy aims to:

- (a) protect resources from surface development where efficient extraction would be jeopardized;
- (b) order extraction so as to avoid a boom and bust situation; and
- (c) request changes to extraction procedures to minimize the inconvenience or annoyance to adjacent property owners.

APPENDIX 6
SAMPLE DATA SHEET
RESPECTING LOCAL INDUSTRY OPERATORS



SOUR GAS PLANT OPERATORS
IN THE CALGARY REGION

LOCATION	FIELDS SERVED	PLANT OPERATOR	ADDRESS AND CONTACT PERSON
10-13-30-7 W/5	Burnt Timber Hunter Valley Wildhorse Creek Panther River	Shell Canada Resources Ltd.	P.O. Box 100, Stn. M Calgary, Alberta T2P 2H5 Doug Mead - Staff Ecologist
13-13-25-5 W/5	Jumping Pound Jumping Pound West Sarcee		
SW 1/4 27-3-30-2 W/5	Carstairs - Crossfield	Home Oil	2300 Home Oil Tower Toronto Dominion Sq. 324 - 8 Ave. S.W. Calgary, Alberta T2P 2Z5 Jim Wurzer - Environmental Co-ordinator
S 1/2 1 and E 1/2 2-26-29 W/4	Crossfield Irricana Crossfield East	Canadian Occidental Petroleum Ltd. (Petrogas)	1500, 365 - 8 Ave. SW Calgary, Alberta T2P 3Z1 Rick Tomasi - Mgr. Special Projects
NE 1/4 14-28-1 W/5	Crossfield East	Amoco Canada Petroleum Co. Ltd.	East Crossfield Plant Box 350, Crossfield Alberta T0M 0S0 Brian Uhrick - Dist. Foreman
2-26-7 W/5	Morley	PanCanadian Petroleum Ltd.	150 - 9 Ave S.W. Calgary, Alberta T2P 2S5 Monte Montemurro
SW 1/4 27-20-29 W/4	Okotoks	Canterra Energy Ltd. (Texas Gulf)	255 - 4 Avenue S.W. Calgary, Alberta T2P 3E7 Ed Plum, Assistant Mgr. Western Production District
4-21-4 W/5	Quirk Creek	Esso Resources Canada Ltd.	Esso Plaza 237 - 4 Ave. S.W. Calgary, Alberta T2P 0H6 Bob Morris, Supervisor, Surface Rights Section

SOUR GAS PLANT OPERATORS
IN THE CALGARY REGION
(continued)

<u>LOCATION</u>	<u>FIELDS SERVED</u>	<u>PLANT OPERATOR</u>	<u>ADDRESS AND CONTACT PERSON</u>
4-6-20-2 W/5	Turner Valley	Western Decalta Petroleum Ltd.	734 - 7 Ave. S.W. 9th Floor Calgary, Alberta Al Lamden, Project Leader
6-16-26-5 W/5	Wildcat Hills	Petro Canada	407 - 2 Street S.W. Calgary, Alberta T2P 3E3 Dennis Kohlman, Senior Environmental Advisor, Environ- mental Protection

APPENDIX 7
REFERENCES



REFERENCES

OIL AND GAS - INDUSTRY AND GOVERNMENT PUBLICATIONS

Alberta Environment. Industrial Sulphur Emissions for Alberta, 1977-81.

Alberta Environment, Land Reclamation Division, Regulated Operations Branch. Information Requirements for Regulated Pipelines. Edmonton, April, 1982.

Alberta Industry-Government Sour Gas Environmental Committee. Guidelines for Urban Development in Relation to the Sour Gas Industry. October, 1974.

De Sorcy, G.J. and H.G. Halladay. "A Forecast of Alberta Sulphur Production." A presentation to 1983 Alberta Sulphur Symposium, Calgary: September, 1983.

Edmonton Metropolitan Regional Planning Commission. "Submission to the Energy Resources Conservation Board on Resource Development and Possible Conflicts with Urban Development in the West Edmonton Area." March, 1983.

Energy Resources Conservatoin Board. Alberta's Reserves of Crude Oil, Gas, Natural Gas Liquids and Sulphur. Calgary, Alberta: ERCB Publication 82-18, December, 1982.

Energy Resources Conservation Board. "Canadian Occidental Petroleum Ltd. - Okotoks Gas Processing Plant." Calgary, Alberta: ERCB Decision Report D83-13, 1983.

Energy Resources Conservation Board. "Minimum Distance Requirements Separating New Sour Gas Facilities from Residential and Other Developments." Calgary, Alberta: ERCB Interim Directive ID81-3, December, 1981.

Energy Resources Conservation Board. "Public Inquiry to Consider Conflicts between Development of Sour Gas Reserves and Residential Development in the Okotoks Area." Calgary, Alberta: ERCB Inquiry Report D83-12, 1983.

Energy Resources Conservation Board. "Public Meeting to Consider Concerns of the Proposed Saddle Ridge Area." Calgary, Alberta: ERCB Decision D83-6, 1983.

Energy Resources Conservation Board. "Resource Development/Urban Development West Edmonton Area." Calgary, Alberta: ERCB Inquiry Report D83-F, 1983.

Energy Resources Conservation Board. "Shell Proposed Moose and Whisky Creek Pipelines and Related Facilities - Kananaskis Area." Calgary, Alberta: ERCB Inquiry Report D83-22, 1983.

Energy Resources Conservation Board. Sour Gas Processing in Alberta. Calgary, Alberta: ERCB Report 82-D, 1982.

Energy Resources Conservation Board. Sour Gas Processing in Alberta. Calgary, Alberta: ERCB, September, 1983.

Federal Department of Energy, Mines and Resources. Sulphur MR 150 Mineral Policy Series.

Intera Environmental Consultants Ltd. Hydrogen Sulphide Hazard Associated with the Sour Gas Operation in the Vicinity of the Town of Crossfield. For the Energy Resources Conservation Board, November, 1976.

Makale and Kylo Planning Associates Ltd. A Study of Land Use and Sour Gas, Okotoks - High River. February, 1983.

Province of Alberta. Revised Statutes of Alberta. Energy Resources Conservation Act, 1980. With amendments to August, 1982.

Province of Alberta. Revised Statutes of Alberta. Oil and Gas Conservation Act, 1980. With amendments to July, 1982.

Province of Alberta. Revised Statutes of Alberta 1980, Planning Act, being Chapter P-9.

Province of Alberta. Subdivision Regulation, being Alberta Regulation 132/78 with amendments up to and including Alberta Regulation 198/79.

Western Research. Environmental Impact Assessment of the Proposed Mazeppa Gas Project. For Canadian Occidental Petroleum Ltd., November, 1982.

Ziegler, P.A. The Development of Sedimentary Basins in Western and Arctic Canada. Alberta Society of Petroleum Geologists, 1969.

GENERAL MUNICIPAL PLANS

Calgary Regional Planning Commission. Airdrie General Municipal Plan. Calgary, CRPC, 1983.

Calgary Regional Planning Commission. Black Diamond General Municipal Plan. Calgary, CRPC, 1980.

Calgary Regional Planning Commission. Chestermere Lake General Municipal Plan. Calgary, CRPC, 1980.

Calgary Regional Planning Commission. Crossfield General Municipal Plan. Calgary, CRPC, 1983.

Calgary Regional Planning Commission. High River General Municipal Plan. Calgary, CRPC, 1983.

Calgary Regional Planning Commission. Okotoks General Municipal Plan. Calgary, CRPC, February, 1980.

Calgary Regional Planning Commission. Town of Canmore & Improvement District No. 8 General Municipal Plan, 1978. Vol. 1 of the General Municipal Plan Study. Calgary, CRPC, 1979.

Calgary Regional Planning Commission. Turner Valley General Municipal Plan. Calgary, CRPC, 1980.

City of Calgary, Planning Department. Calgary General Municipal Plan. Calgary, 1978.

Municipal District of Rocky View No. 44. The Municipal District of Rocky View No. 44 General Municipal Plan. Calgary, Municipal District of Rocky View No. 44, 1983.

REGIONAL PLANS & POLICIES

Battle River Regional Planning Commission. The Battle River Regional Plan. Wetaskiwin, BRRPC, 1982.

Calgary Regional Planning Commission. Calgary Regional Plan. Calgary, CRPC, 1984.

Calgary Regional Planning Commission. Calgary Regional Plan. Calgary, CRPC, 1984.

Edmonton Metropolitan Regional Planning Commission. Proposed Edmonton Metropolitan Regional Plan. Draft for public discussion. Edmonton, EMRPC, 1982.

Oldman River Regional Planning Commission. Oldman River Region: Draft Regional Plan. Lethbridge, ORRPC, 1982.

Red Deer Regional Planning Commission. Regional Plan. Red Deer, RDRPC, 1984.

South Peace Regional Planning Commission. South Peace Regional Plan. Grande Prairie, SPRPC, 1983.

Southeast Alberta Regional Planning Commission. Southeast Alberta Regional Plan. Medicine Hat, SARPC, 1983.

OTHER LAND USE PLANNING DOCUMENTS

Alberta Energy and Natural Resources, Resource Evaluation and Planning Division. Ghost River Sub-Regional Integrated Resource Plan. August, 1983.

City of Calgary, Planning Department. Annexation Study. Calgary, February, 1983.